Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPARTMENT
APR 26 1947
DETROIT

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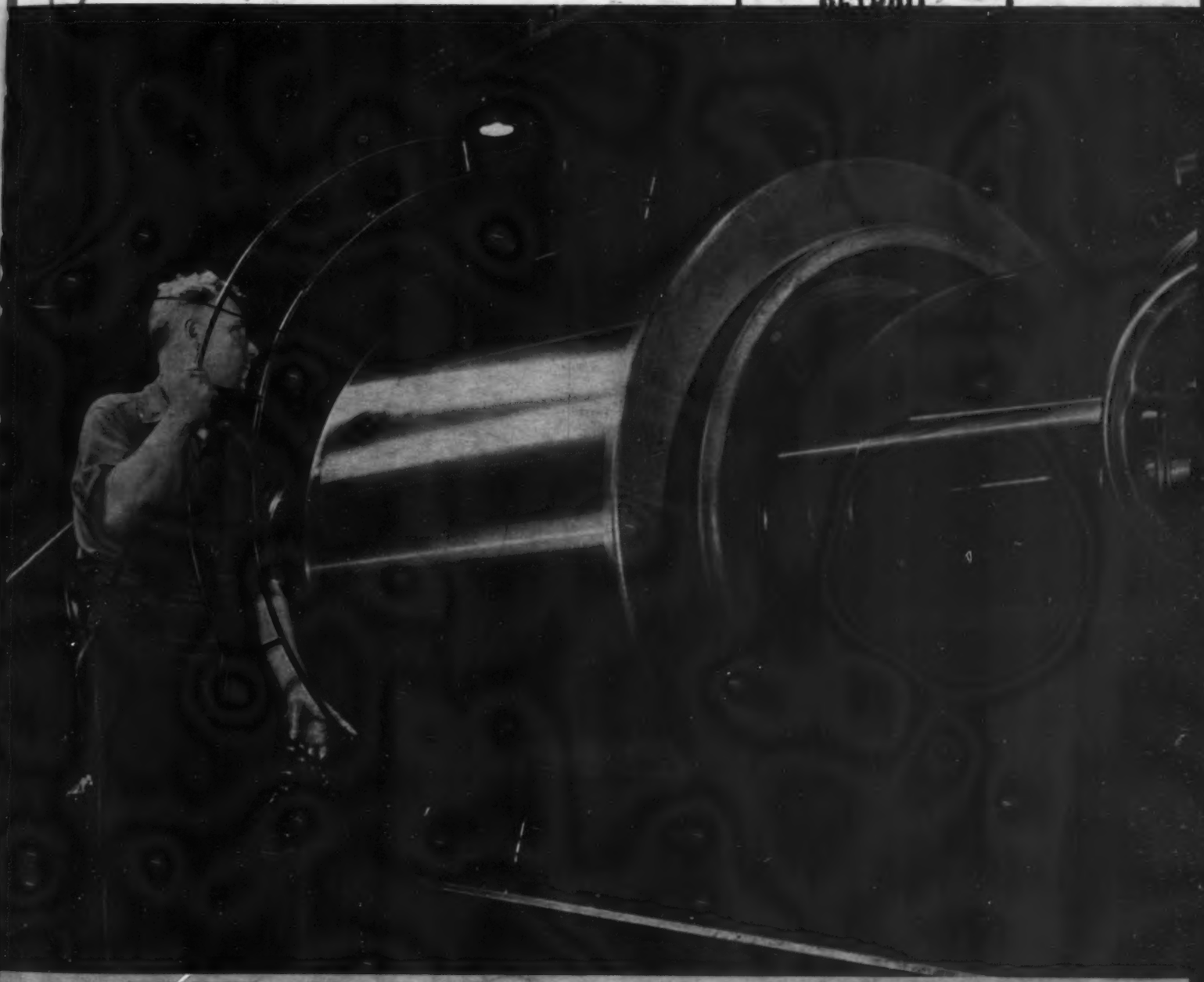
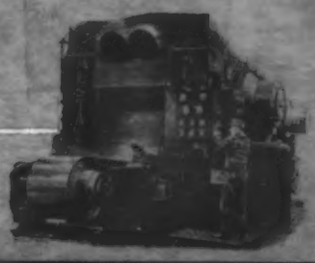
APRIL, 1947

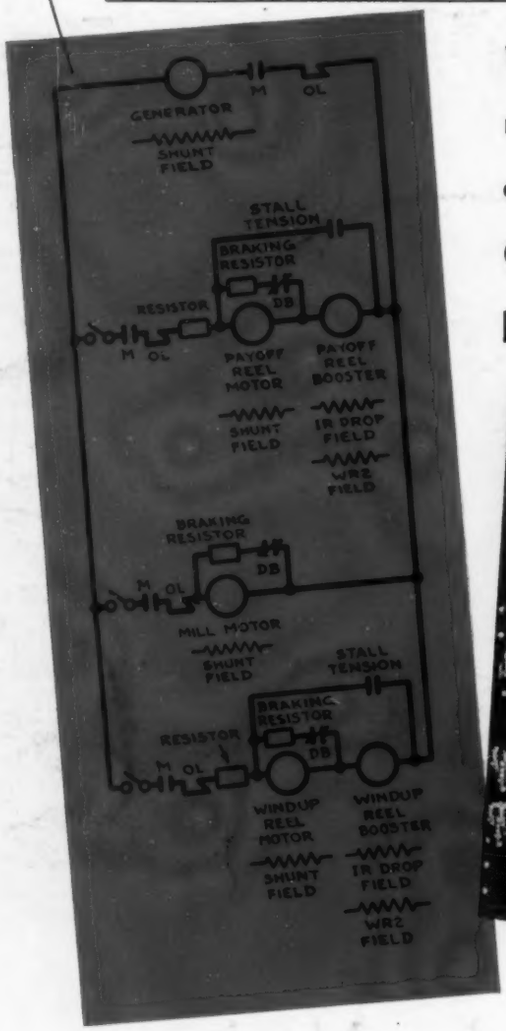


MESTA 56" x 51" SPECIAL ALLOY CAST STEEL BACKING UP ROLL FOR A MODERN FOUR-HIGH HIGH SPEED COLD REDUCTION MILL



MESTA MACHINE COMPANY · PITTSBURGH, PA.

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.



When you equip a processing line or group of machines with individual motors supplied by a D-C generator . . . *that calls for a* Cutler-Hammer 14049 custom built D-C Adjustable Voltage Controller

Cutler-Hammer bulletin 14049 control offers any combination of the following functions:

1. Linear speed changes of process equipment by voltage adjustment on the main generator set.

2 Jogging of all units individually or in any combination, either forward or reverse.

3. Pre-selected running speeds.

4. Manual loop control by means of vernier rheostats; or automatic loop control by means of mechanical or photo-electric limit switches or photo-thyratron control.

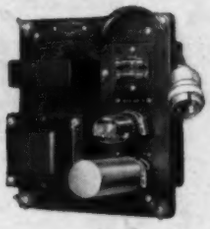
5. Constant tension control to compensate for changes in coil diameter on uncoilers and/or re-coilers.

Cutler-Hammer bulletin 14049 D-C Adjustable Voltage Control is built throughout to the famed Cutler-Hammer standards of dependability, ruggedness and simplicity. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

TYPICAL COMPONENTS OF CUTLER-HAMMER MILL CONTROL

Cutler-Hammer control desk. Sloping top for easy visibility. Front slanted for toe room.

Synchronous motor starter for motor generator set.



Quick-change unit control panel for photo-electric limit switch.

CUTLER-HAMMER
MOTOR CONTROL
C-H

STEEL • COPPER • BRASS • ALUMINUM •

PRODUCERS AND FABRICATORS

*----------"At Your Service"

At Your Service . . . .

If you produce or fabricate steel, copper, brass, or aluminum, remember our business is one of making your job easier and your product better, by designing and manufacturing efficient production equipment.

Many of our designers and engineers spend all of their time in the development of better ways of rolling, forming, drawing or otherwise fabricating ferrous and non-ferrous materials.

Many of the innovations or improvements originate in the field with you, and the shirt-sleeve specialists of both companies collaborate in perfecting developments. Working at the elbow of users always has been a policy of The Aetna-Standard Engineering Company.

Three factors — confidence of you, the customer; thoroughness and experience of our men; plus quality of our products, make possible the continuous advancement in production equipment.

Best known for tube and pipe mills, coating equipment and flat finishing equipment, Aetna-Standard manufactures hundreds of products for the production and fabrication of ferrous and non-ferrous materials.

Remember the name — Aetna-Standard . . . At Your Service.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY: HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

PRECISION ROLL MAKERS
Since 1909

National today, as at no other time in its respected history, is better prepared to furnish the good iron and alloy iron rolls you need – when you need them.

For real roll service call upon our experience and unexcelled manufacturing facilities. National service extends from basic engineering through controlled casting and precision machining to delivery as scheduled. And National roll users know that in terms of tonnage formed and long service life these rolls fully meet every expectation.

National Rolls

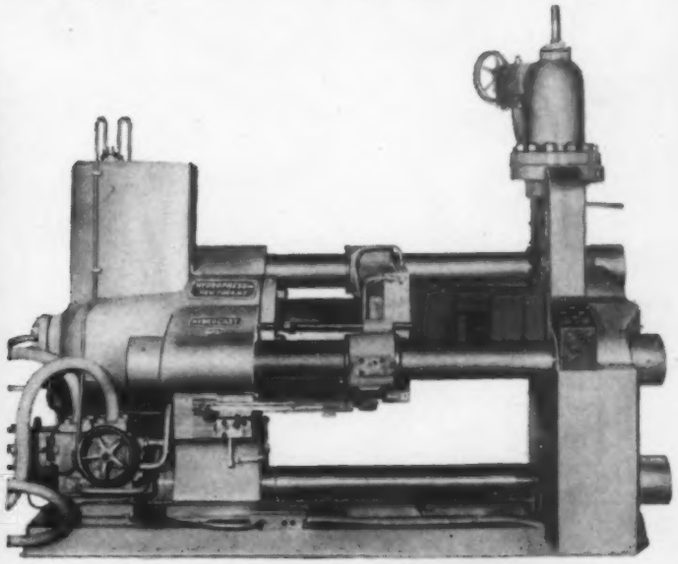
THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

HYDROCAST (TRADE-MARK)

COLD CHAMBER DIE CASTING MACHINES

DESIGNED TO CAST THE ALLOYS OF COPPER, ALUMINUM, MAGNESIUM AND ZINC FROM 3 cu. in. TO 300 cu. in.

FULL-HYDRAULIC SELF-CONTAINED SEMI-AUTOMATIC ELECTRICALLY CONTROLLED



LET US KNOW YOUR INDIVIDUAL **DIE CASTING PROBLEM** WE WILL WORK IT OUT IN ACCORDANCE WITH YOUR SPECIAL REQUIREMENTS **ASK FOR OUR LITERATURE L-24**

HYDROPRESS · INC.

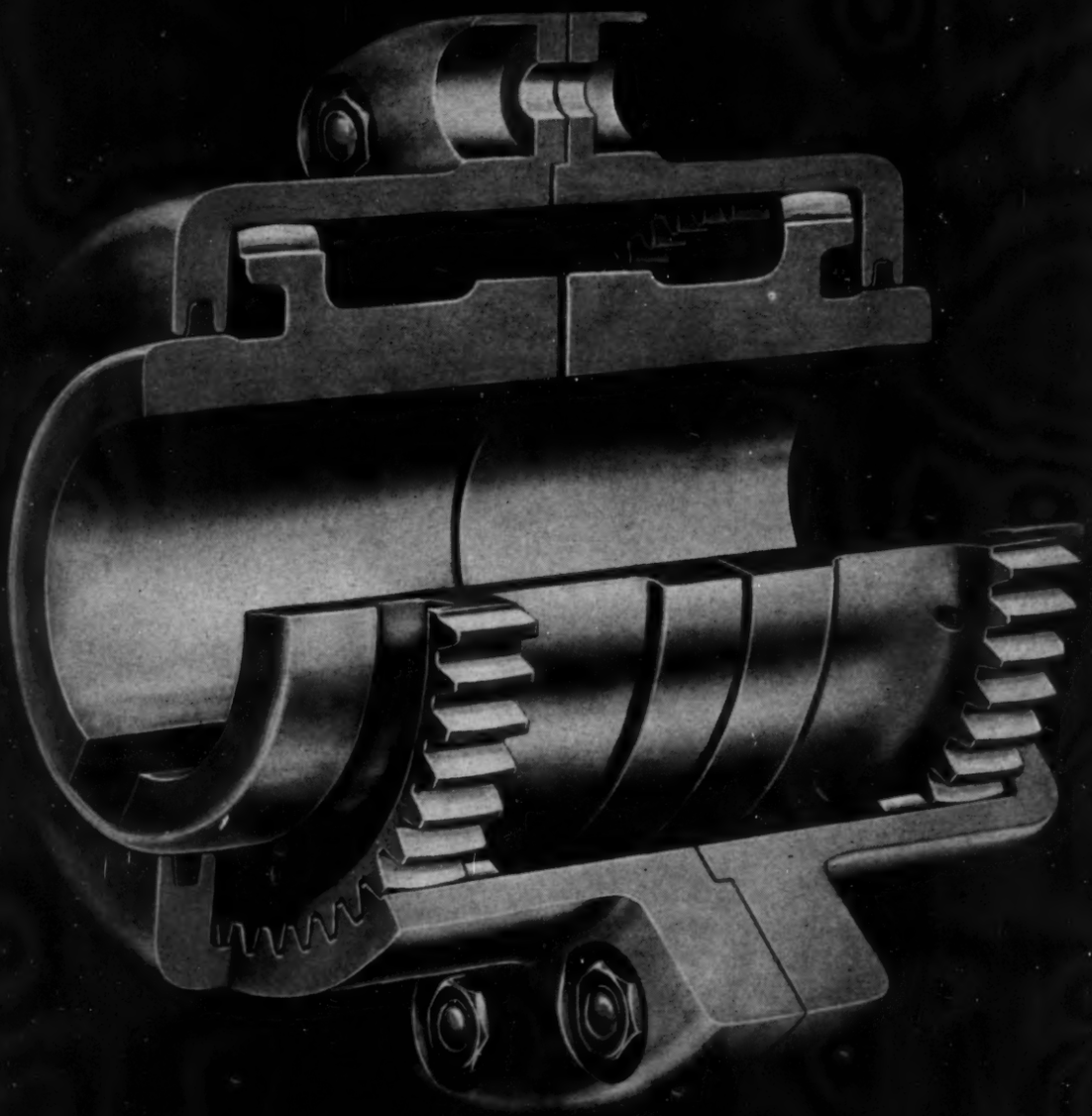
ENGINEERS *CONTRACTORS*

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS ACCUMULATORS · DIE CASTING MACHINES

566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

DENVER DETROIT SEATTLE WASHINGTON D.C.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

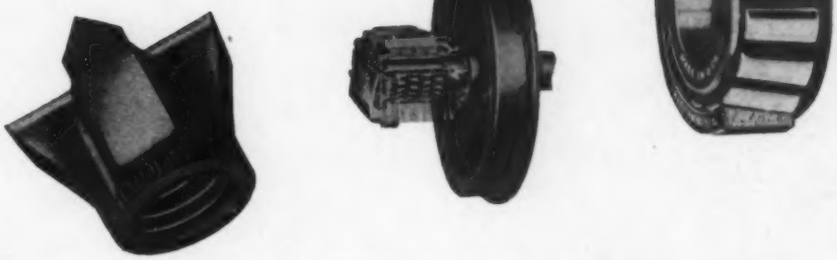
FLEXIBLE COUPLINGS

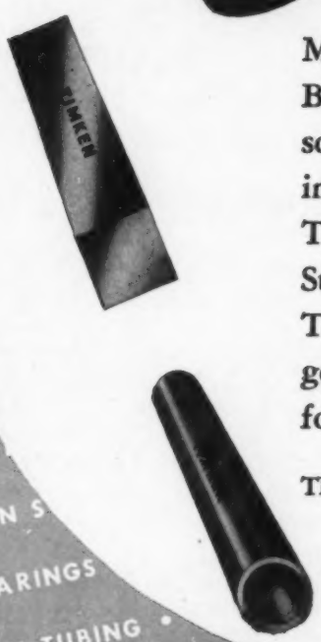
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.





Means "Made By The Timken Roller Bearing Company." It identifies the source of Timken Tapered Roller Bearings, Timken Railroad Roller Bearings, Timken Alloy Steel, Timken Seamless Steel Tubing and Timken Rock Bits. This trade-mark is your assurance of getting genuine Timken products. Look for it when buying.

THE TIMKEN ROLLER BEARING COMPANY
CANTON 6, OHIO

NO MORE LUBRICATION WORRIES!

...thanks to RELIANCE *Series C* MOTORS

This special bearing design protects Reliance Series C Motors indefinitely!

You can't grease 'em wrong! That's because Reliance Series C Motors are designed and precision built to eliminate lubrication worries. In most uses, these factory-lubricated motors perform dependably *for years* with no additional lubrication. Where unusual conditions make occasional attention necessary—or if it is your practice to lubricate at regular intervals—undergreasing or overgreasing can make no difference.

Send coupon below for the whole story of how Reliance Series C Motors end your lubrication worries!

RELIANCE ELECTRIC & ENGINEERING CO.

1084 Ivanhoe Road **Cleveland 10, Ohio**

Appleton, Wis. • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Denver • Detroit • Gary Grand Rapids • Greenville, S. C. • Houston • Kansas City • Knoxville • Los Angeles • Milwaukee Minneapolis • New Orleans • New York • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke, Va. Rockford • St. Louis • San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D. C. Sao Paulo, Brazil

RELIANCE A·C D·C MOTORS

RELIANCE ELECTRIC & ENGINEERING COMPANY
1084 Ivanhoe Road
Cleveland 10, Ohio

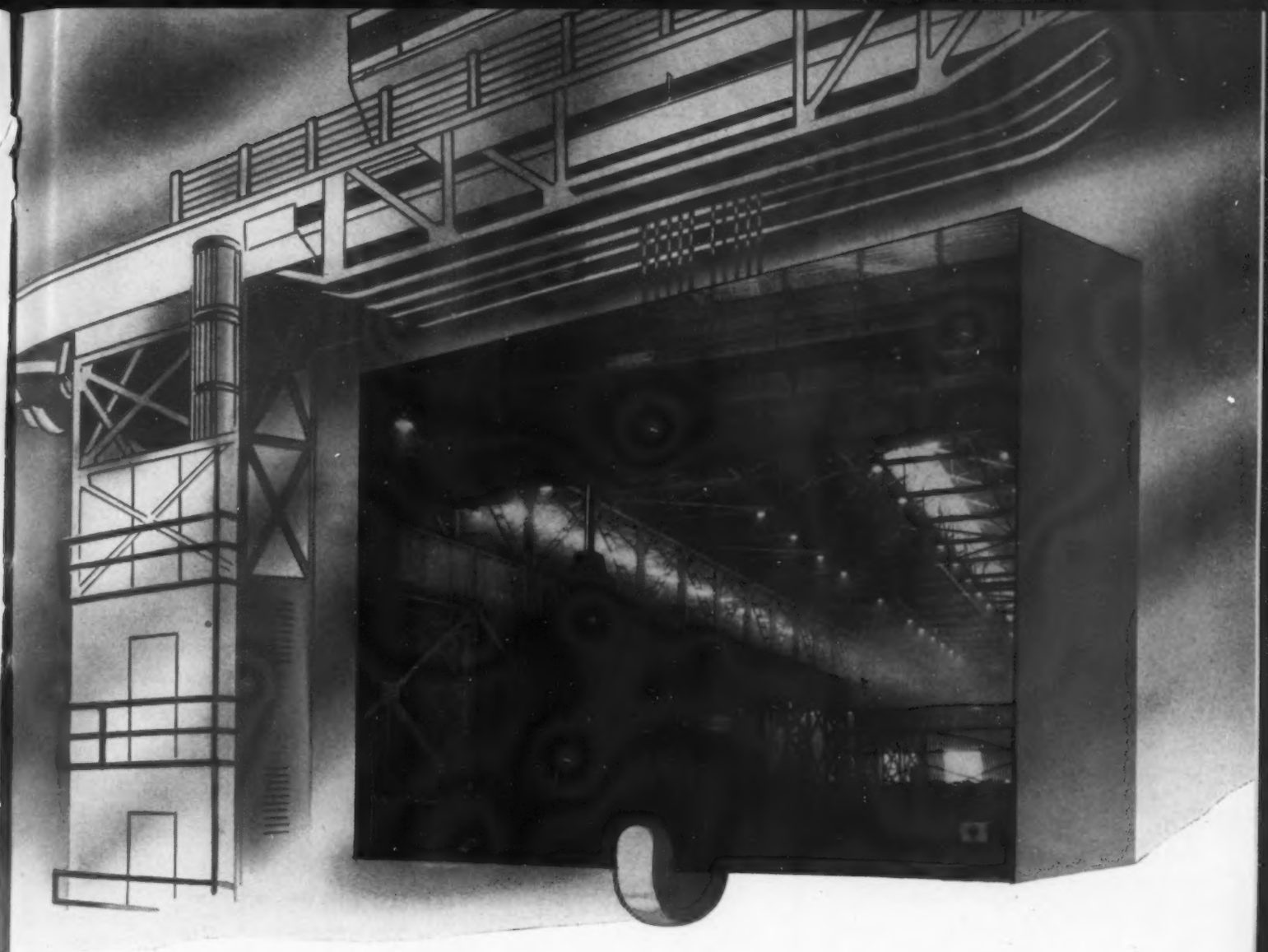
Please send me your Bulletin C-118 which explains the advantages of Reliance Series C Motors.

NAME..... TITLE.....

COMPANY .....

ADDRESS.....

CITY..... ZONE..... STATE.....



Alliance—world's largest crane builder—gives you another *first* in crane design

● One of the newer developments of The Alliance Machine Company is this 300-ton, 100' span, electro-hydraulic forge crane. Located in the steel works of one of the country's largest steel corporations, it's used to handle forgings under a 7,000-ton capacity forging press.

This crane is of unique design inasmuch as the hydraulic pump is located on the trolley, the pump being driven by a series motor. Every movement of the crane is directed by remote control, the operator being stationed on the floor, near the press.

With the pump located on the trolley, this crane has the same range of operation as a standard electric overhead traveling crane. Heretofore, cranes of this type obtained hydraulic power from a pump located on the floor, this power being conveyed by means of walking pipes which limited the range of operation. Formerly, all hydraulic cranes were lowered by gravity only, with no pressure applied in the lowering direction. The new Alliance crane shown here has pressure applied on the hoist cylinder in both the lowering and hoisting directions.

Attached to the lower end of the piston rod is a power-driven turning rig, over which a link chain functions. This link chain supports the ingot to be forged under the press. The motor for turning this rig is located on the trolley of the crane, and power is conveyed through a spline shaft in the hollow piston rod.

Contact Alliance—world's largest builder of the world's largest cranes—for complete information on this new development in electro-hydraulic forge cranes.

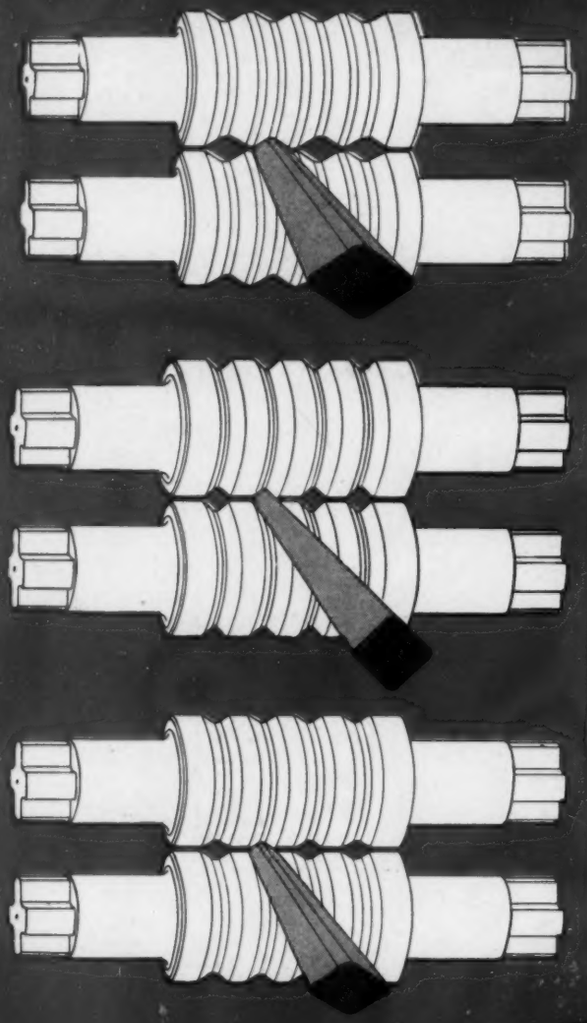
THE ALLIANCE MACHINE COMPANY

Main Office: Alliance, Ohio ✱ Pittsburgh Office: 1622 Oliver Bldg.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS
SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET
CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Alliance

ROLLING TECHNIQUE . . .

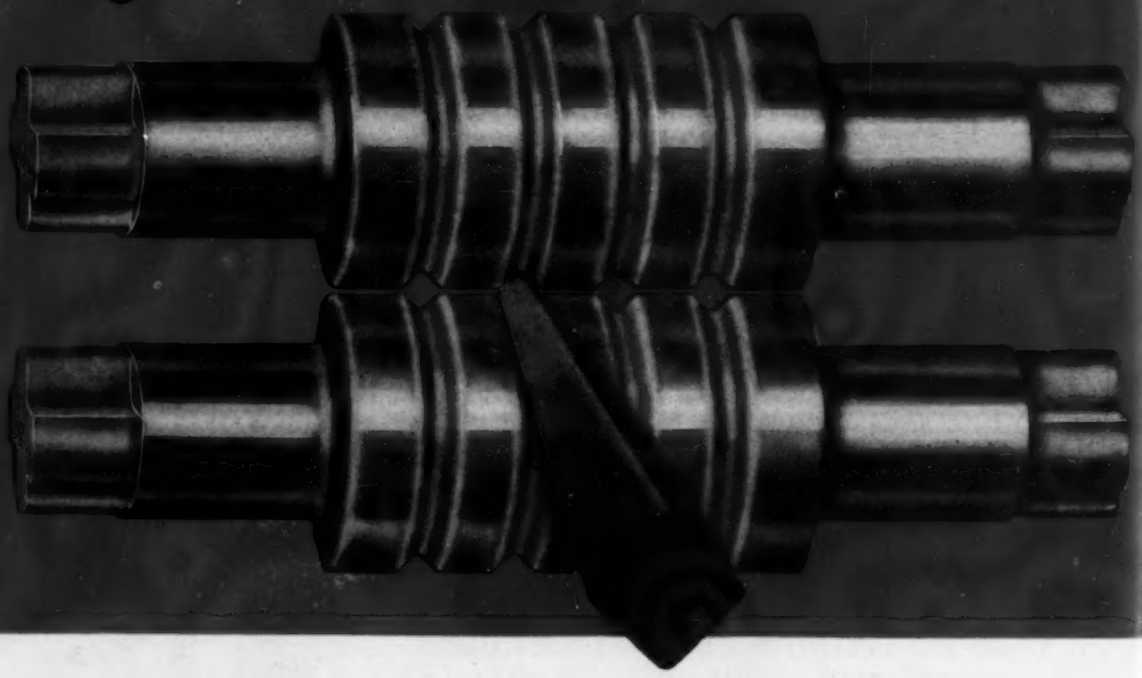


Billets

Billet Mills are designed and built with the prime purpose of producing high tonnages of semi-finished steel. This requires rolls that will stand up over a long period and still retain a smooth surface, thus keeping billet reconditioning cost at a minimum.

Pittsburgh Rolls are made by skilled craftsmen whose thorough practical knowledge of metallurgy, foundry methods and accuracy in roll turning is the accumulated result of over seventy-five years devoted to the exclusive manufacture of Rolling Mill Rolls. The use of Pittsburgh Rolls can result only in *less cost per ton of steel rolled.*

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.



PITTSBURGH ROLLS

Keep Production Rolling

Use Effective Lubrication to Prevent Stoppages

FOR dependable, trouble-free performance from high-speed steel and aluminum strip mills, and other heavy machines in continuous operation, use effective lubrication—TEXACO! For example —

Texaco Regal Oils are heavy circulating oils that keep circulating systems clean and machinery efficient. They have high stability, separate rapidly from water, strongly resist emulsification, oxidation and sludge formation. They prolong the life of bearings, gears and other parts — prevent costly stoppages, repairs and replacements.

To protect enclosed, heavy-duty gear drives and bearings, use *Texaco Meropa Lubricants.* They prevent bearing corrosion, and have a higher load-carrying capacity than any shock loads or pressures encountered.

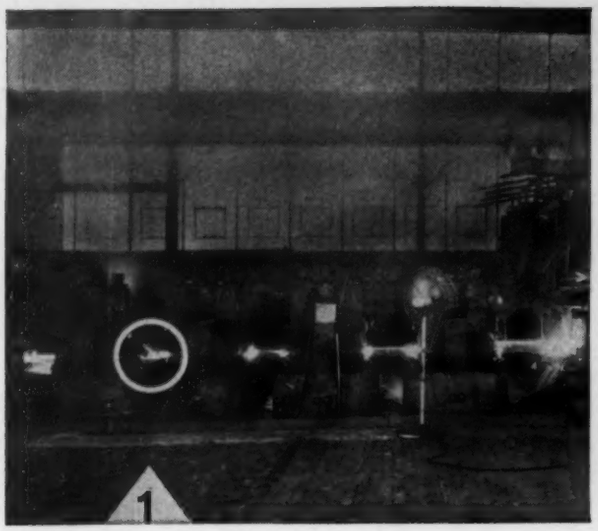
Keep production rolling in *your* mill with Texaco Products and Lubrication Engineering Service. Call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

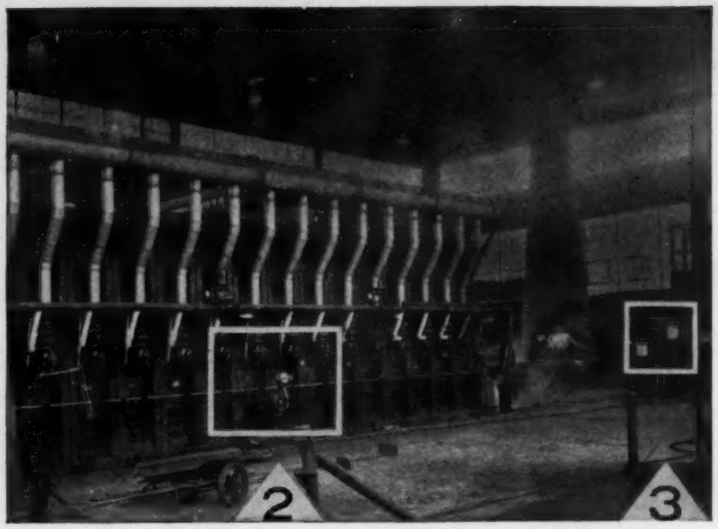
TEXACO

TEXACO Regal Oils

(HEAVY DUTY CIRCULATING OILS)

Tune in . . . TEXACO STAR THEATRE presents the NEW TONY MARTIN SHOW every Sunday night. See newspaper for time and station.





NARROW TEMPERATURE BAND FOR ROEBLING'S ROD ROLLING

Held By L&N Pyrometers On Furnace and Mill

Automatic control which can be applied to many complex temperature problems is illustrated by the pyrometer setup in John A. Roebling's rod rolling plant. Two L&N Pyrometers, with Rayotubes as detectors, work as a team to maintain correct rod temperature both before and during rolling.

A Micromax instrument records the temperature of the big 15-burner oil-fired Morgan furnace, and through its Control Unit activates the valve drive which regulates heating of the whole furnace. A Speedomax Recorder supplies a continuous, prompt record of rod surface temperature, as the rods move through the rolling mill.

With the information that these micro-sensitive and dependable instruments give, the operator can avoid the cobbles which result if rods are fed into the mill too hot, and the flats and "finny" ends which are the penalty for too cold rods. The overall result is smoother production, with practically no rejects.

Catalogs N-33B and ND46(1) describe the two pyrometers. If you have a particular problem, an L&N field engineer will be glad to discuss it with you.

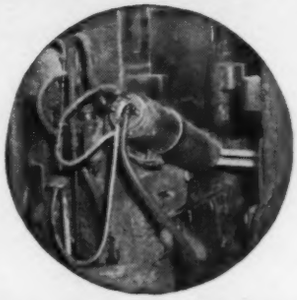
LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

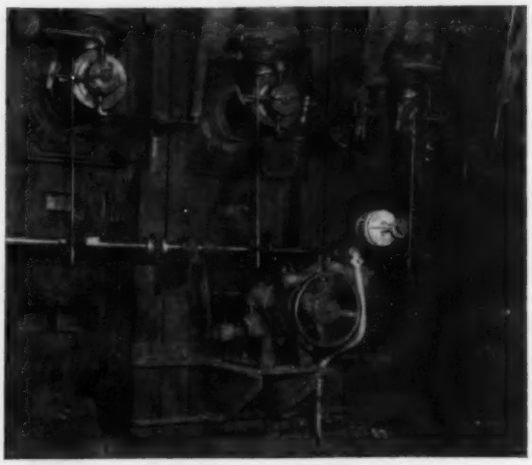
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad N-33B-685(2)

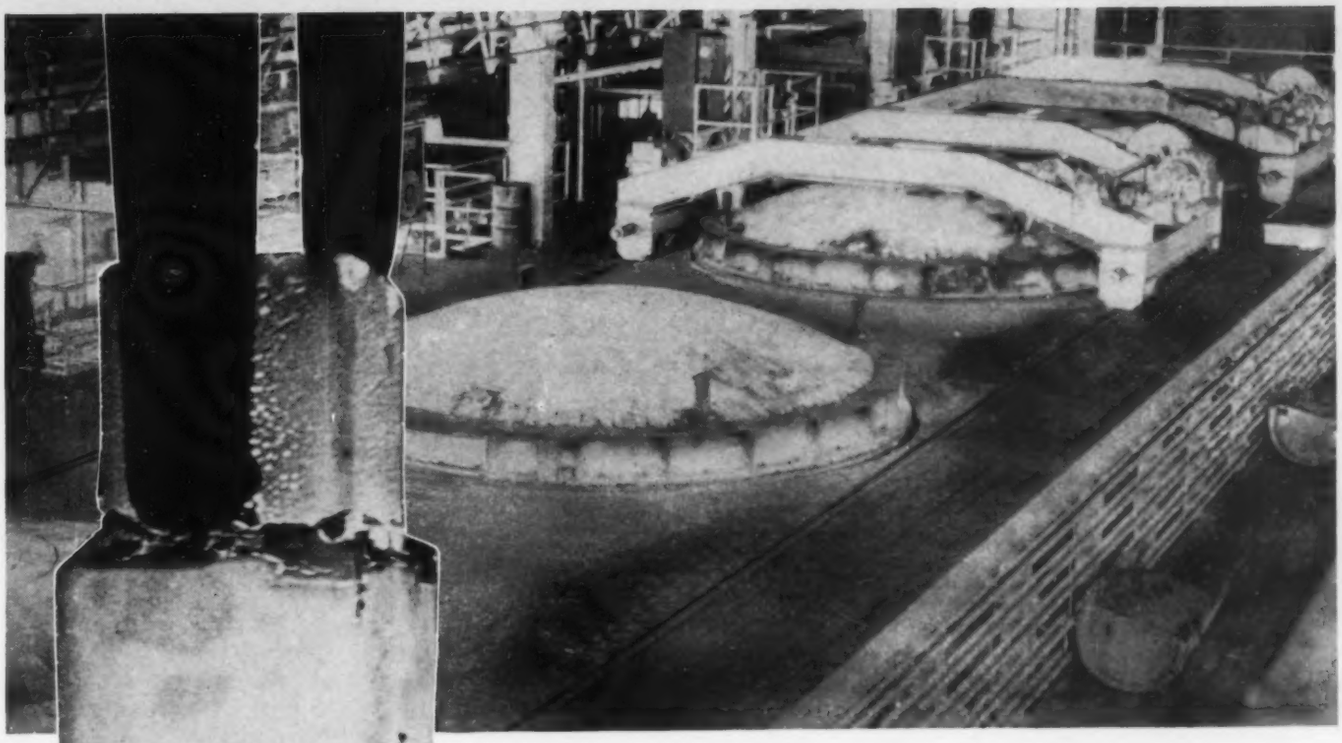
1 Temperature of Rod in Mill. Rayotube in water jacket sights on two rods as they enter the third pass of the Morgan Mill. Rayotube reports temperature to Speedomax for recording. John A. Roebling's Sons Co., Roebling, N. J. plant.





2 Furnace temperature is detected by the Rayotube shown projecting into the furnace wall, and recorded by a Micromax Pyrometer. Control is through the Drive Unit linked to each of the fifteen Hauck burners, for regulating both fuel and air to the Morgan Construction Company furnace.

3 Left-hand instrument is the Speedomax Recorder which records temperature of rods passing through mill, photo (1). Beside it, the Micromax instrument controls furnace temperature (2).



Here's an absolutely unretouched photo—observe the results.

THE SALEM CIRCULAR SOAKING PIT

This pit utilizes the full luminous-type combustion. It also has ample pit pressure, thus assuring absolute uniformity of the ingot, temperature-wise . . . from side to side and top to bottom, regardless of the size or shape of ingot. The circular shape of the pit permits the long luminous flame to spread evenly throughout the furnace and blankets the ingots on all sides. High pit pressure assures ample retention time of the flue products in the pit to provide the most effective interchange of heat from the flue products to the steel.

SALEM ENGINEERING CO. · SALEM, OHIO

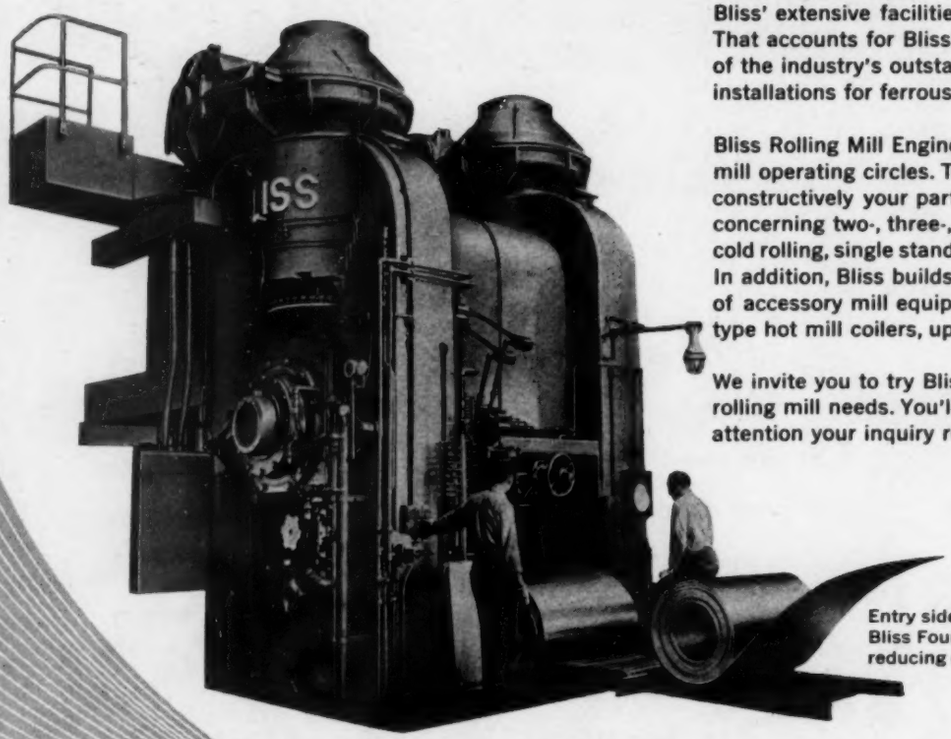
TORONTO, ONTARIO, CANADA LONDON, ENGLAND

SALEM

Salem builds

CIRCULAR SOAKING PITS
ROTARY HEARTH FURNACES
CONTINUOUS BUTT-WELD FURNACES
CAR BOTTOM FURNACES
FORGE FURNACES
HEAT TREATING FURNACES
NEEDLE METALLIC RECUPERATORS
AIR RECIRCULATING FURNACES
GAS ATMOSPHERE FURNACES
MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES

Rolling Mill "know-how" for the asking...



Entry side of 21" x 50" x 72" Bliss Four-High Mill for cold reducing of aluminum.

No rolling mill equipment problem is too large for Bliss' extensive facilities—design and production-wise. That accounts for Bliss' ability to work out some of the industry's outstanding sheet and strip mill installations for ferrous or non-ferrous application.

Bliss Rolling Mill Engineers are well-traveled in mill operating circles. They're equipped to analyze constructively your particular requirements concerning two-, three-, or four-high mills for hot and cold rolling, single stand reversing or tandem operation. In addition, Bliss builds cluster mills and a variety of accessory mill equipment including mandrel type hot mill coilers, upcoilers, slitters, reels, etc.

We invite you to try Bliss on your current rolling mill needs. You'll like the prompt attention your inquiry receives.

STAY AHEAD WITH *Bliss*

E. W. BLISS COMPANY

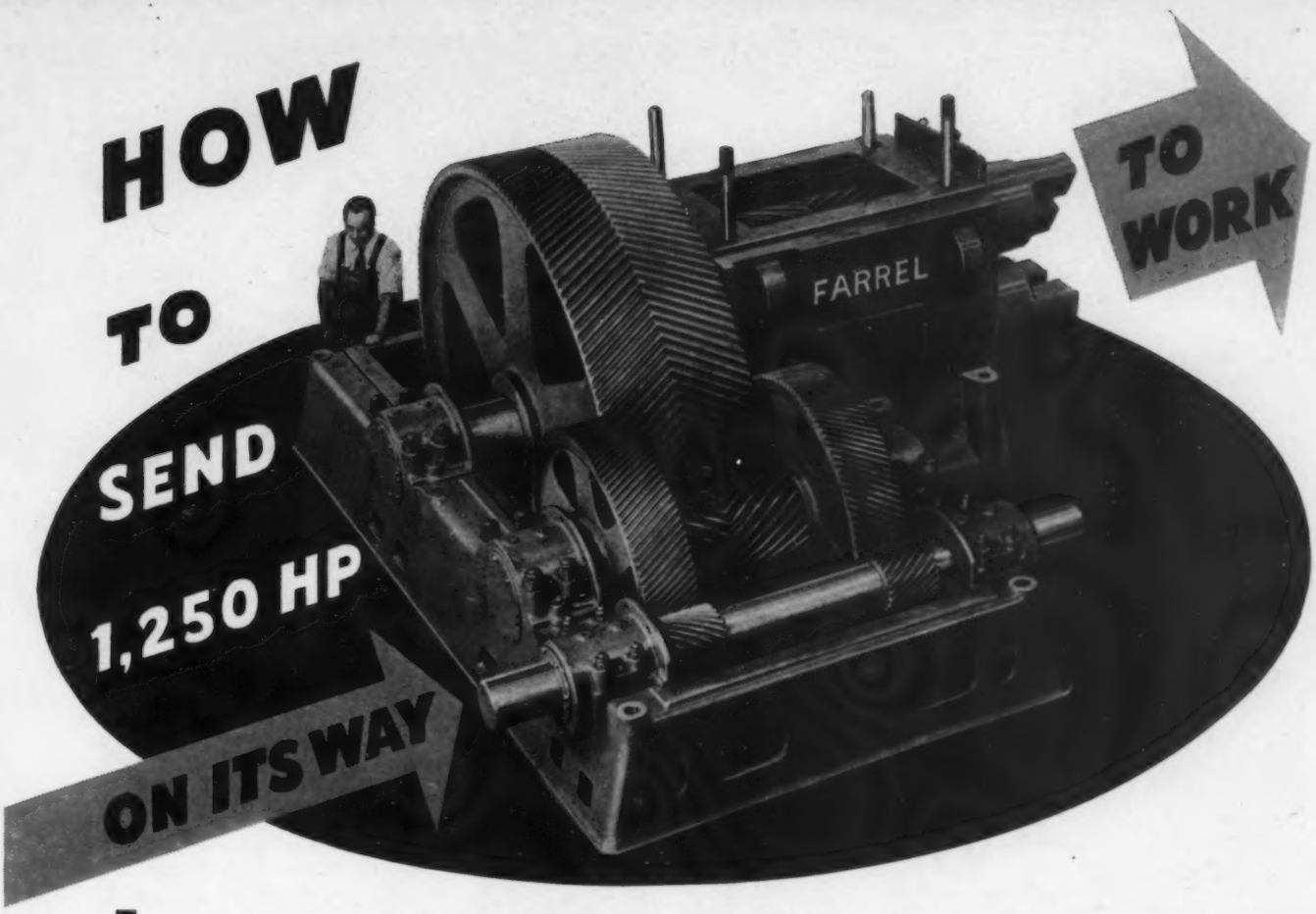
Rolling Mill Division
Salem, Ohio

rolling mills

mechanical and hydraulic presses

can and container machinery

HOW TO SEND 1,250 HP ON ITS WAY TO WORK



This Farrel combined mill drive and pinion stand is designed to send 1250 HP smoothly, efficiently on its way from motor to mill.

Here are some of the construction features which protect its smooth and lasting operating efficiency.

GEARS AND MILL PINIONS—The first reduction consists of divided double helical gears. The second reduction gears and the mill pinions are the Farrel-Sykes herringbone type. In these gears the *backbone* formed by the juncture of the helices makes the teeth continuous across the face, providing extra strength and load-carrying capacity.

SHAFTS—Accurately ground shafts are of large diameter for extra rigidity to prevent torsional deflections.

BEARINGS—Anti-friction bearings hold shafts in precise alignment and reduce friction loss to a minimum.

HOUSING—Heavy, double-walled, cast housing, with welded steel cover and pan for the gear unit, provides required rigidity to maintain correct alignment of gears and pinions.

LUBRICATION—Main gears are dip-and-splash lubricated from a reservoir of extra large capacity. Other gears, mill pinions and bearings are force-feed lubricated by separate pump. The lubricating system is provided with protective devices to guard against oil contamination or circulation failure.

Farrel mill drives and pinion stands are built in any capacity, separate or combined, with specifications to fit your individual requirements. Complete information and engineering help are available on request, without obligation. FB-379

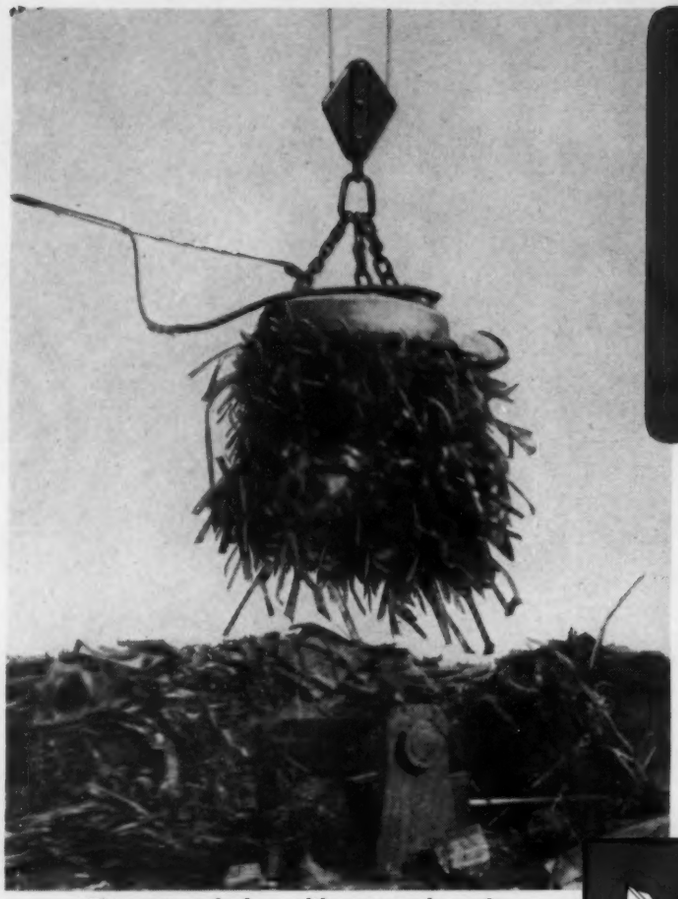
FARREL ROLLING MILL MACHINERY

Rolls	Mill Pinions
Rolling Mills	Pinion Stands
Rod Mill Tables and Manipulating Equipment	Gear Drives of any Capacity
Universal Mill Spindles	Flexible Couplings
Rod Coilers	Roll Grinding Machines
Gears	Roll Calipers
	Lead Presses for Pipe or Rod

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, Stonington, New York, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston, Charlotte.

Farrel-Birmingham



"This extremely large lift was made under normal conditions," reports H. K. Hardcastle of our Philadelphia office.

The EC&M Type SW All Welded LIFTING MAGNET Furnishes Its Own Proof

Yields Big Lifts of Scrap and Pig Iron because--

1. Elimination of pole-shoe bolt-recesses permits a better proportion of coil-space inside the magnet-housing and a more effective magnetic path.

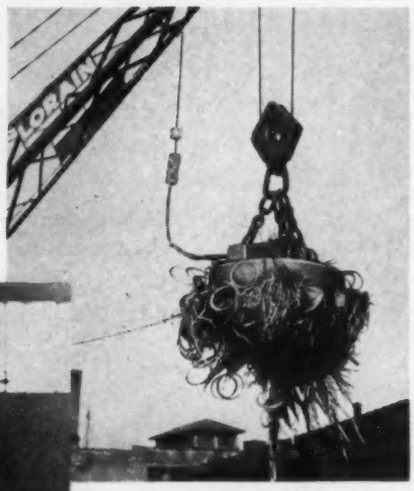
2. Pole shoes are affixed by welding to the magnet-housing. No bolts to stretch and allow an air-gap in which rust, dirt or foreign material can collect and prevent a snug refit. No cored holes in pole shoes—instead, solid rings of metal mated tightly and permanently to the machined surfaces of the magnet-housing.

● Users are saying, *"Best circular lifting magnet in the field."* This advanced design using all-welded construction, provides maximum lifting ability over the entire working-surface or bottom of the magnet.

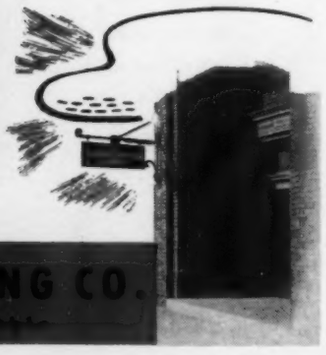
Note, in the illustrations above and at right, that the face or underside of the magnet is completely filled with material to the extreme edges around the outer circumference.

Also observe that these magnets have smooth sides and top—nothing to catch on the side of a railroad car—no dirt-catching pockets on top.

For *fast-handling* of material in scrap yards, iron and steel plants, etc., Type SW *All-Welded* Magnets are available in several sizes. Bulletin 900 gives complete details. Write for a copy.



Headquarters of the All-Welded Lifting Magnet



THE ELECTRIC CONTROLLER & MANUFACTURING CO.

N·B·M MILL BEARINGS ARE *Custom-Tailored* TO YOUR CONDITIONS

N·B·M
BRONZE AND
COPPER CASTINGS

Blast Furnace Copper Castings

Roll Neck Bearings

Slippers • Housing Nuts

Machinery Castings • Babbitt Metals

Acid Resisting Castings

Phosphorized Copper

American Brake Shoe metallurgical research has perfected scores of different bronze alloy formulas to meet every combination of factors which affect mill bearing performance.

Our expert engineers know how to apply this rich experience to solve your bearing problems — increase your production and cut your maintenance costs. May we show you how?

NBM

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
PITTSBURGH • NEW YORK

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Multiply the **USEFUL HOURS** of your recreational facilities

.... by floodlighting your field for NIGHT games

Crouse-Hinds Type MUA Alumalux Floodlight

Crouse-Hinds Type MDB-14 Floodlight

A Nationwide Distribution Through Electrical Wholesalers

More people can participate in your outdoor athletic program and many more of them will become interested spectators when your field is lighted with

CROUSE-HINDS FLOODLIGHTS

A well lighted field that extends play-time into night-time will work wonders in boosting employee enthusiasm. The resulting good-will pays dividends on the modest investment that is required.

Pioneer in sports lighting, Crouse-Hinds Illumination Department has a wealth of experience acquired through more than twenty years of planning the most efficient lighting for all types of fields from small playgrounds to great stadiums. This know-how is at your service. Crouse-Hinds illuminating engineers will gladly recommend the proper selection and arrangement of floodlights for any application.

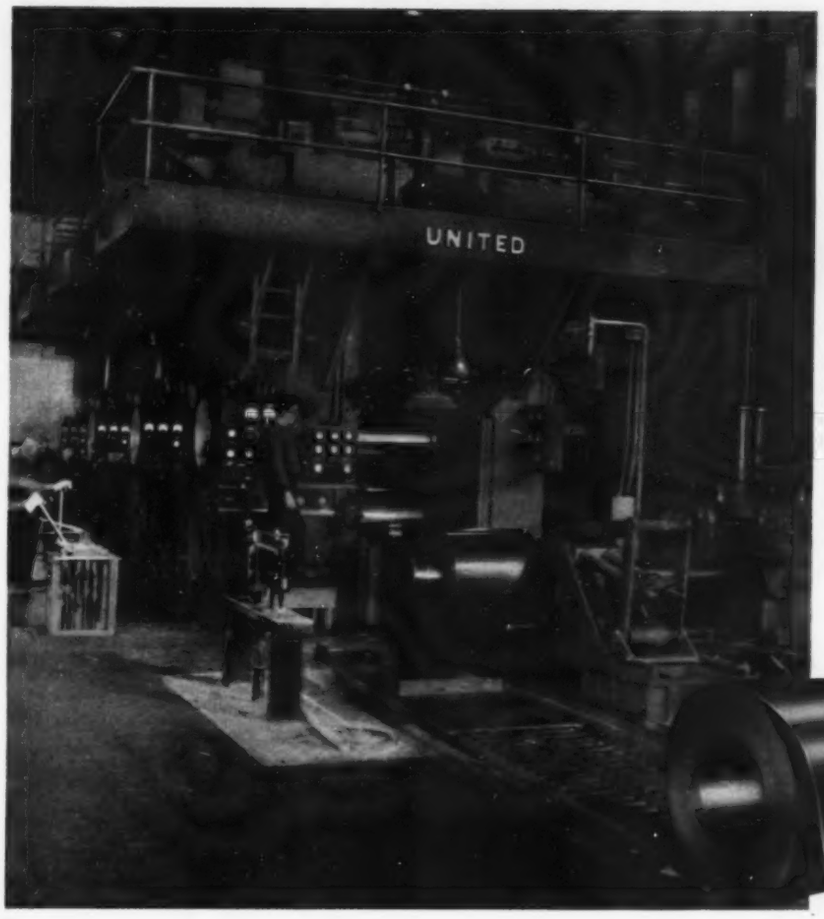
Send for the latest Crouse-Hinds Sports Lighting Bulletin. It contains the National Electrical Manufacturers' Association standard floodlight layouts for a large number of sports, from horseshoe courts to baseball fields.

Our 50th Anniversary 1897 – 1947

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

Offices: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — Minneapolis New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — Washington. *Resident Representatives:* Albany — Atlanta — Charlotte — New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

FLOODLIGHTS · AIRPORT LIGHTING · TRAFFIC SIGNALS · CONDULETS



UNITED

4-STAND TINPLATE MILL

The canning industry—America's largest user of tinplate—depends largely upon progress in the development of new and better steel rolling and coating processes to broaden its ever growing usefulness to the public.

One step in the process of making better tinplate for canning is the giant new United mill shown in operation. Designs for this, and other mills with production speeds up to 5000 feet per minute, are available for duplication, or for revision to suit your requirements. UNITED's engineers will be glad to confer with you concerning your plans for increased tinplate production.

UE&CO
REG. T. M.

UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

Hagan

AIR OPERATED

SOAKING PIT CONTROLS

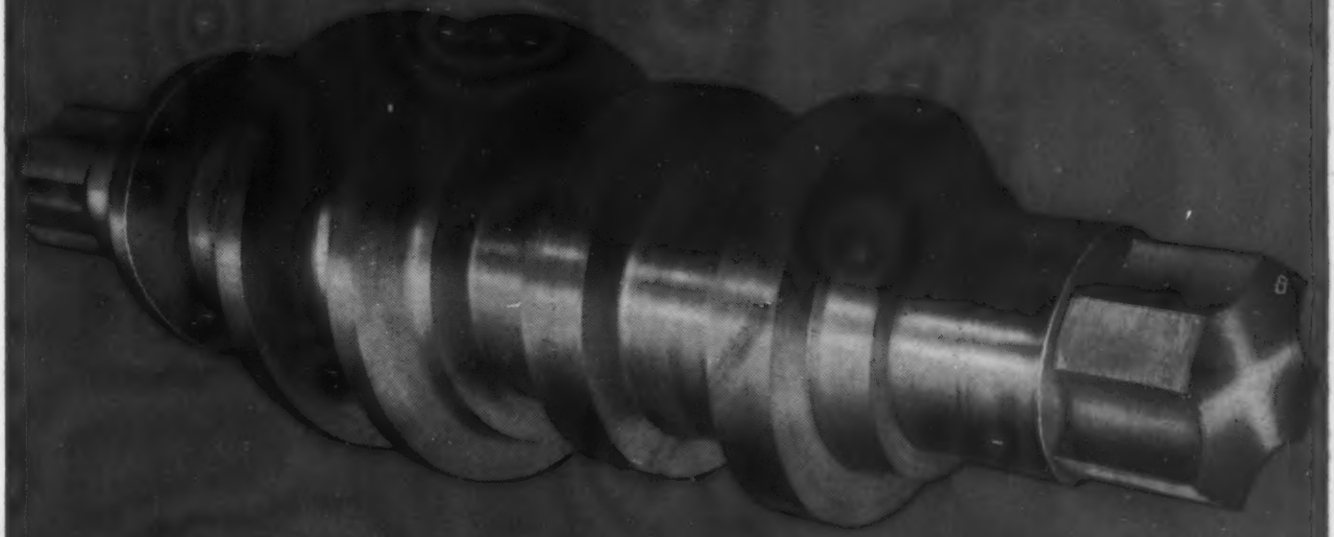
The first installation of these controls has completed one full year of satisfactory operation.

Our engineers will be glad to give you full information.

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PA.

Where STRENGTH is the Prime Requirement



BIRDSBORO

30

ROLLS

Birdsboro 30 Rolls are the strongest and toughest of Alloy Steel Rolls used for blooming, cogging and roughing—Aircraft Quality Steel (High Percentage Alloy Type)-Stainless Steel (High Percentage Alloy Type)-High Speed Steel—and all rollable steel that is very difficult to reduce because of density.

Consult our Roll Engineers if you are experiencing difficulty with Rolling Ingots and Billets of the above steels.

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

BIRDSBORO

ROLLS

BAKER TRUCKS *help lower* PRODUCTION COST OF *Ford* TRACTORS

Unloading racks of Ford Tractor parts from highway trailer with Baker Fork Trucks. Trucks tier these racks in convenient storage areas and transport them to assembly lines.

The essential relation between "mass production" and "engineered material handling" is effectively demonstrated at Ford's huge Highland Park, Mich., tractor plant. Here modern mechanized handling facilities consisting of hoists, roller conveyors, sliding ways and a fleet of Fork Trucks, keep materials moving in a highly integrated, efficient flow pattern reducing handling costs to a minimum.

Wherever possible, parts and materials are handled on pallets. Incoming shipments not palletized by suppliers are usually palletized upon arrival—and the ultimate aim is to have all suppliers ship on pallets. Certain parts, such as tractor fenders, arrive nested on tierable racks (see illustration). Besides cutting costs by eliminating individual piece-by-piece handling, this "unit load" system permits tiering to conserve storage space.

Baker Material Handling Engineers are prepared to recommend similar cost saving methods for your plant.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Company
2166 WEST 25th STREET • CLEVELAND, OHIO
In Canada: Railway and Power Engineering Corporation, Ltd.

EITA

Member: Electric Industrial Truck Association

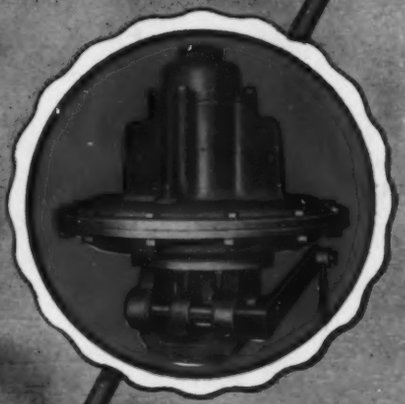
1311-1-47

Baker INDUSTRIAL TRUCKS

SERIES 600

DIAPHRAGM AIR MOTORS

Furnished as one unit — complete with North American Adjustable Port Valves.



Used with pneumatic type instruments for throttling control of air, gas, oil, water or steam.

by NORTH AMERICAN

For Combustion

THE NORTH AMERICAN MFG. CO.

GAS OR OIL COMBUSTION EQUIPMENT • BRANCH OFFICES IN PRINCIPAL CITIES

CLEVELAND 5, OHIO

Adjustable Port Fuel Valve and Motor

Butterfly Air Valve and Motor

Adjustable Port Air Valve and Motor

Exide

IRONCLAD BATTERIES

BUILT FOR PEAK PERFORMANCE AND LONG LIFE IN HEAVY-DUTY SERVICE...

The Exide-Ironclad is a different type of battery . . . in design, construction, service qualities. It was developed to meet the need for a battery to deliver high, sustained power in heavy-duty service over a long period of time.

THE POSITIVE PLATE is unique in battery design. It consists of a series of slotted, vertical, hollow tubes which contain the active material (See illustration at left). The slots in the tubes are so fine that, while they permit easy access to the electrolyte, they prevent the lead oxide from readily washing out, thus adding considerably to the life of the plate.

THE NEGATIVE PLATE has been designed and is built to equal the increased life of the positive plate. Like the positive plate, it has two feet at the bottom to raise it above the two supporting ribs.

SEPARATORS are made of Exide Mipor, a special rubber composition, and will match the long life of Exide-Ironclad plates. The cutaway illustration shows how separators rest on ribs well below bottom of plates, thus making probability of internal short circuits very remote.

THE EXIDE-IRONCLAD ASSEMBLY is sealed in jars of Giant Compound. Jars are practically unbreakable in normal service.

THE RESULT is an efficient, ruggedly built battery that assures dependable performance, long life and maximum economy . . . a battery that fully measures up to each service requirement . . .

★ ***HIGH POWER ABILITY*** . . . needed in frequent "stop and go" service.

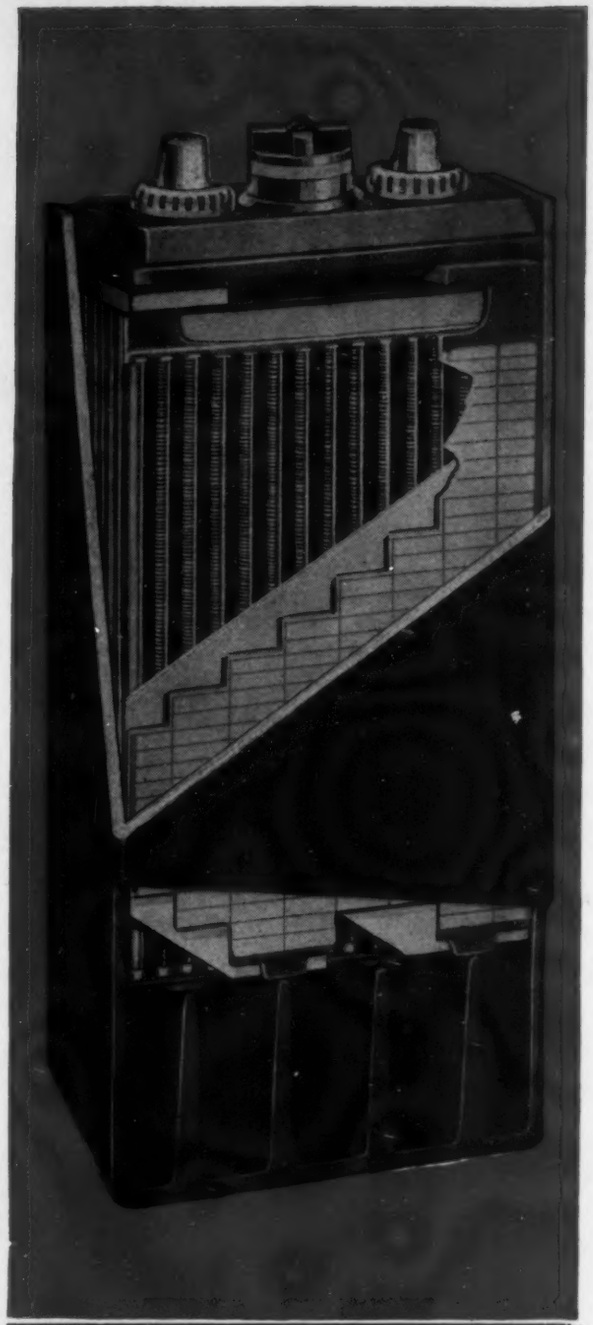
★ ***HIGH MAINTAINED VOLTAGE*** throughout discharge.

★ ***HIGH ELECTRICAL EFFICIENCY*** that keeps operating costs low.

★ ***RUGGED CONSTRUCTION*** . . . for long life.

Exide-Ironclads are supplied in sizes to suit every make and type of electric industrial truck.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



- Use limit 3000 F
- Melting point 3190 F
- High spalling resistance
- Low volume change on initial firing
- Negligible reheat shrinkage
- Ease of application

—these are among the important properties which make B&W KAOCAST an outstanding castable for high temperature applications, ranging from the use limit of standard castables up to as high as 3000F.

B&W KAOCAST, which can be either rammed or poured into place, will effect significant savings in such uses as:

1. forming special shapes
2. furnace linings
3. car tops
4. patching brickwork
5. covering studs in water-cooled furnaces

For more information on this remarkable new development of B&W Refractories Research, send for the informative B&W KAOCAST Bulletin — or call your local B&W representative.

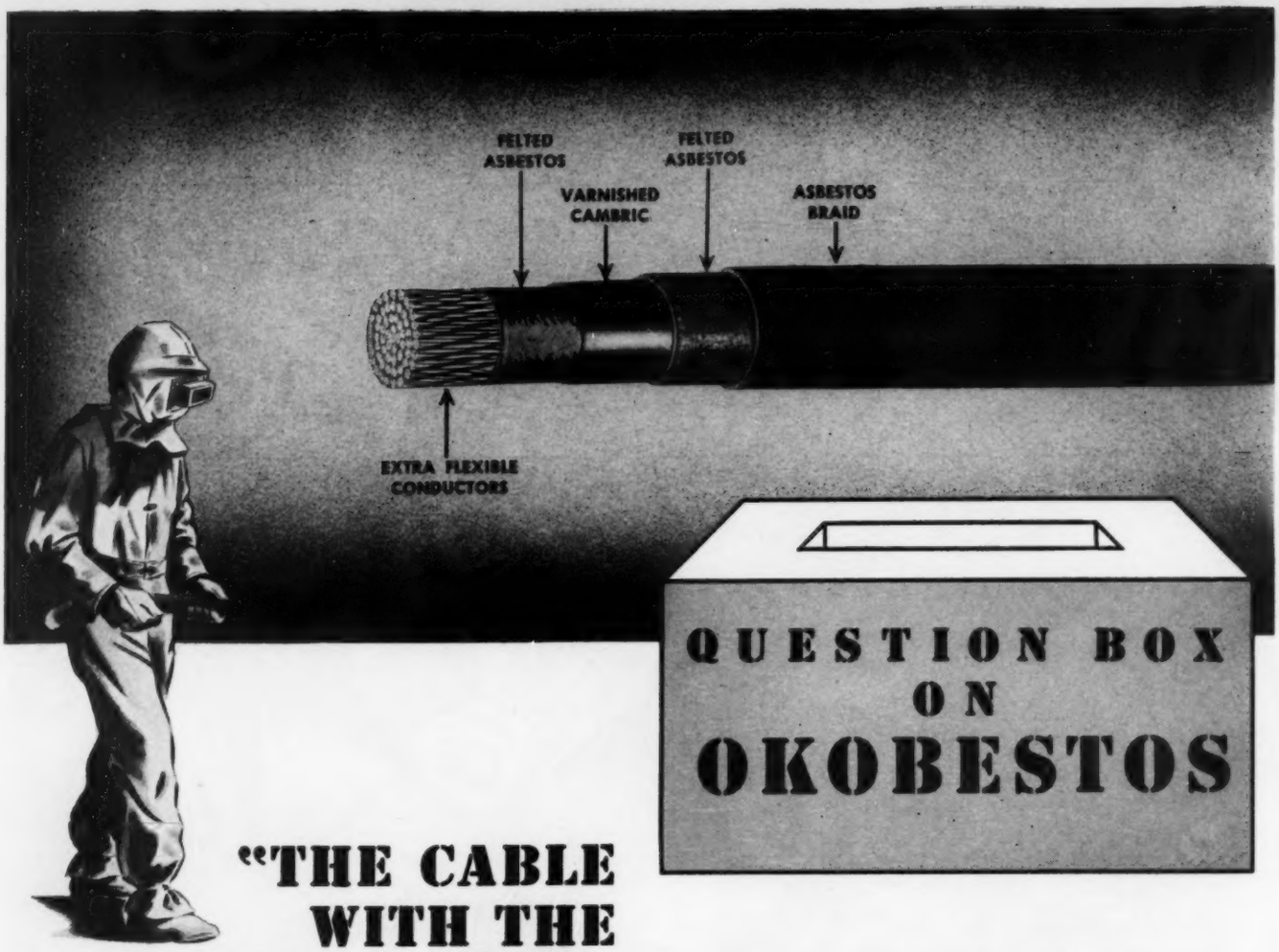
B-282

B&W

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.



QUESTION BOX ON OKOBESTOS

"THE CABLE WITH THE ASBESTOS SUIT"

Q. What material, famous for fire-resistance, has established a record for permanence in electrical wires and cables for hot locations?

A. Asbestos.

Q. In what form is it most useful in this service?

A. Impregnated felted asbestos insulation.

Q. Is this type of insulation available in an Okonite cable?

A. Yes. You'll find it in Okobestos, "the Cable with the Asbestos Suit."

Q. Where is this cable particularly valuable to engineers in charge of electrical installations?

A. In "hot spots" — in service where high temperatures are continuously encountered . . . near boilers, furnaces, soaking pits, annealing ovens for example.

Q. What is the construction of a typical Okobestos Cable?

A. (1) Conductors of Okoloy-coated copper covered with (2) a layer of felted asbestos impregnated with a heat- or moisture-resisting compound, over which is applied (3) varnished cambric in a succession of helical tape wrappings to form a layer of high dielectric strength insulation covered in turn by (4) another layer of felted asbestos insulation similar to the first and finally (5) a double asbestos braid, woven from heavy asbestos fibre threads, impregnated with a black moisture-resisting compound.

Q. Is Okobestos corrosion resistant?

A. Yes — it's a good choice wherever corrosive fumes, chemicals, oils and solvents are found.

Q. Are Okobestos cables mechanically strong?

A. Yes. They have no organic outer coverings to rot or to mildew.

Q. Where can I find out more about the different types of Okobestos cable that are available?

A. In Bulletin OK-2061 which describes a number of different types, voltage ranges and applications. Write for a copy on your business letterhead addressed to The Okonite Company, Passaic, New Jersey.

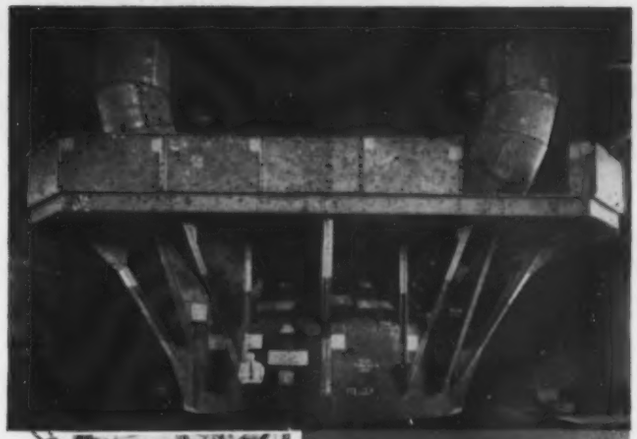
HEADQUARTERS FOR ANSWERS:

OKONITE SINCE 1878

5094

from
TOP
to
BOTTOM

POLLOCK gives you precision fitting in all steel plate construction work



Blast Furnaces

Hot Metal Cars and Ladles

Ingot Mould Cars

Cinder and Slag Cars

Charging Box Cars

Welded Open Hearth Ladles

Welded Steel Products

Let Pollock handle your next steel plate fabrication and erection job, for Pollock skilled experts have had years of experience . . . can give you precision fitting every time! Before leaving the shop, all parts are assembled and carefully match-marked to insure close, accurate fits and speedy erection in the field. So carefully is this done that one customer — 12,000 miles away — has ordered steel work from Pollock **three** times, and each time was able to do his assembling quickly and easily. In another instance, the Pollock Company tore down and rebuilt the steel work for an **entire** blast furnace which was out of operation only 83 days, setting a new world record and saving over 20,000 tons of pig iron.

You, too, can benefit from Pollock's broad experience . . . its complete facilities and well-trained engineering-designing staffs. Whatever your fabricating job — large or small — heavy or light — put it up to Pollock and see how you save!

The WILLIAM B. POLLOCK CO.

YOUNGSTOWN, OHIO

•

STEEL PLATE CONSTRUCTION

ENGINEERS FABRICATORS ERECTORS

CALL ON ALLIS-CHALMERS FOR...

THIS 7,000 HP MOTOR

operating a 44-inch reversing blooming mill is capable of exerting a repeated operating torque of 225 per cent of rating, and can exert 275 per cent of normal torque before circuit is interrupted.

THREE PANEL CONTROL BOARD AND EXCITER SET

for the 7,000 horsepower reversing blooming mill motor. The number of contactors required is reduced to a minimum by the use of the *Regulex* control set described at the right. Fewer contactors greatly simplifies the installation and maintenance of control equipment.

Transformers

Switchgear and Switchboards

Rectifiers

Motors for Mill Drives

ALLIS

1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

One of the Big 3 in Electric Power Equipment—

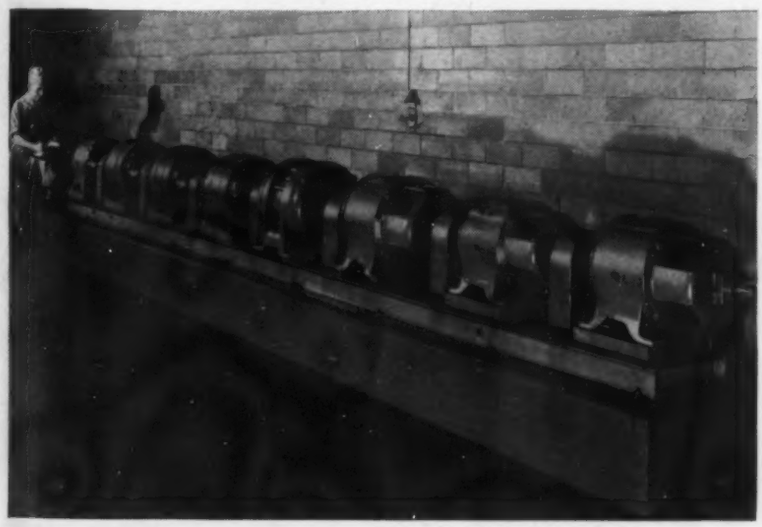
COMPLETE MAIN MILL DRIVES!

Whether you need power for a Blooming, Slabbing, Roughing or Finishing Mill, a Hot Strip Mill or a Cold Reduction Mill, Allis-Chalmers can help you!

OVER FIFTY YEARS' experience in the design and manufacture of electrical machinery has given Allis-Chalmers the ability to fulfill *completely* any main mill power and control requirements.

Here's typical evidence. In a large midwestern steel plant, from the Reversing Blooming Mill to the Finishing Mill, Allis-Chalmers has furnished *all* the main mill drives and control.

When you deal with Allis-Chalmers you enjoy practical benefits of A-C's long years of experience —you benefit by sturdy, generously proportioned design and long lasting construction which is typical of Allis-Chalmers equipment. ALLIS-CHALMERS, MILWAUKEE 1, WIS.



REGULEX EXCITER SET INSTALLATION

Regulex control provides uniformity of acceleration and maximum speed stability, and reverses motors in less than 2 seconds with current automatically limited to a safe operating value.

ALLIS-CHALMERS SYNCHRONOUS M-G SET

used to support a 5,000 horsepower intermediate mill motor. Set consists of two 2,000 kw, 700 volt d-c generators driven by a 6,000 hp, 6600 volt, 514 rpm synchronous motor.

A 2214

CHALMERS

Steam and Hydraulic Turbines

Centrifugal Pumps

Blowers and Compressors

Texrope V-Belt Drives

Biggest of All in Range of Industrial Products

Quick Low-Cost Way to Load a Freight Car

Big palletized unit loads, handled by powerful battery fork trucks make light work of car loading and unloading — save time, muscle and money. In such work the 10% extra capacity construction pioneered by Philco is a distinct advantage—provides more work energy to handle more tons and load more cars per shift. Write for specification data on Philco extra capacity types XL, XVL and the long-life "Philco Thirty".

PHILCO

STORAGE BATTERIES

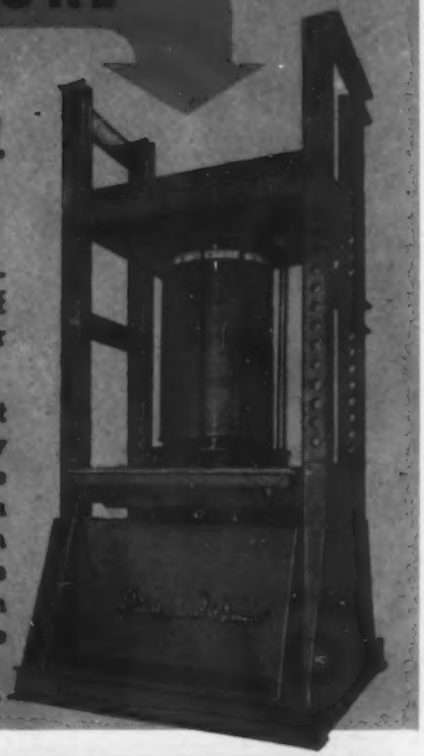
PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

PUTTING ON THE PRESSURE

GIVES POSITIVE PROOF THAT YOUR TRANSFORMER WILL WITHSTAND SHORT CIRCUITS

It's sure. It's positive. No guess work. No wishful thinking. Putting on the pressure is an added measure of safety engineered into every Pennsylvania Transformer with helical or pancake coils.

THIS IS WHAT WE DO — We calculate the total short circuit force that would be produced by a short circuit at the secondary terminals with the rated voltage maintained on the primary. We compress the coils with this pre-determined force and treat them in such a manner that they are self-supporting, and will maintain their shapes when mounted on the core. Strong supports are provided at the top and bottom of the coils to keep the coils in their precompressed shapes. No movement can take place in the transformer coils, even under the most severe short circuit.

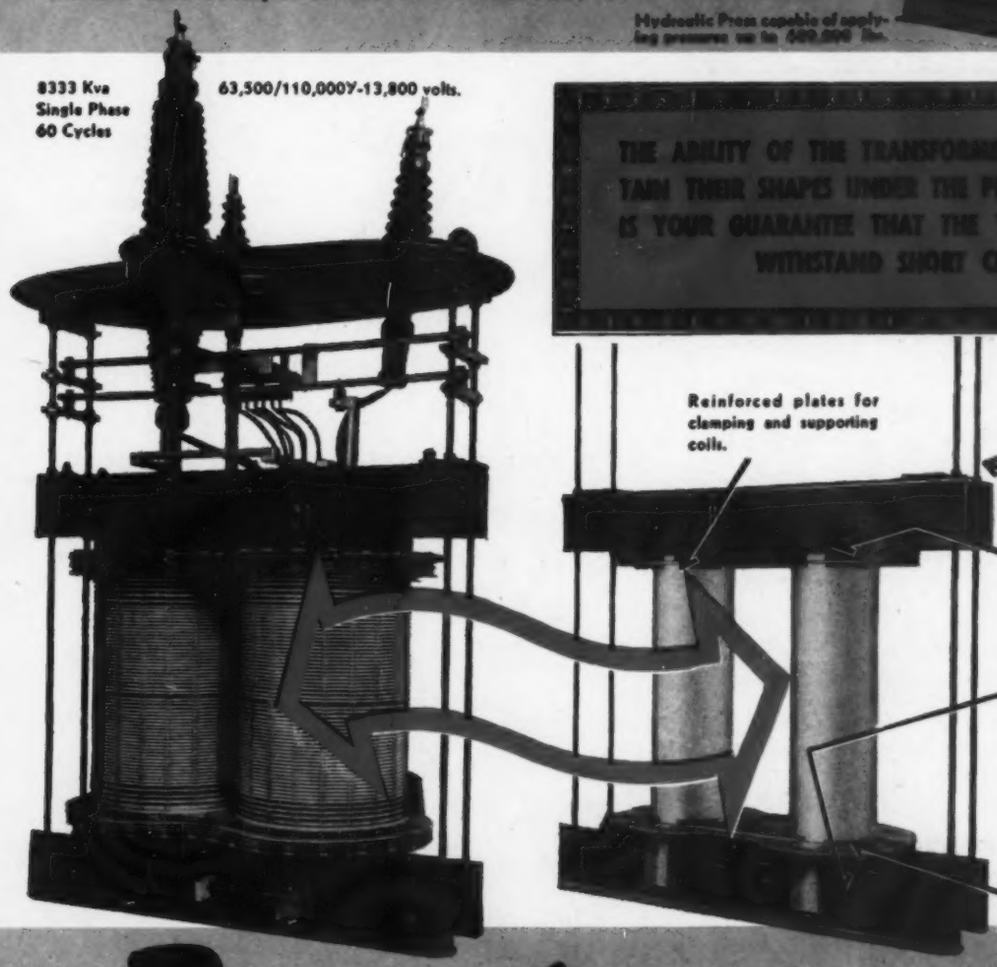


Hydraulic Press capable of applying pressures up to 600,000 lbs.

8333 Kva
Single Phase
60 Cycles

63,500/110,000Y-13,800 volts.

THE ABILITY OF THE TRANSFORMER COILS TO MAINTAIN THEIR SHAPES UNDER THE PRESCRIBED PRESSURE IS YOUR GUARANTEE THAT THE TRANSFORMER WILL WITHSTAND SHORT CIRCUITS.



Reinforced plates for clamping and supporting coils.

Tie rods for connecting top and bottom core frames and for clamping coils.

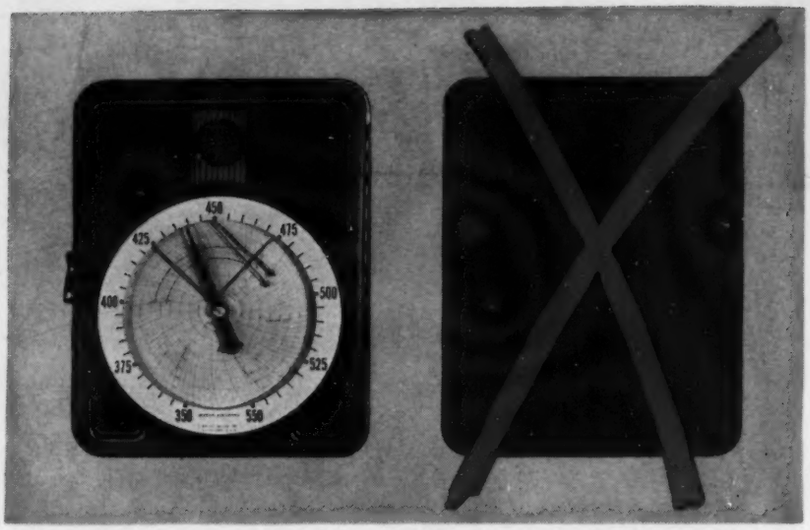
Clamping plates hold coils to their precompressed size. Note the ruggedly constructed side-frames, the extra strong bolts, nuts and rods.

Drum cut away to permit cooling oil to flow past core steel.

Pennsylvania
TRANSFORMER CO., PITTSBURGH, PA.

Pennsylvania TRANSFORMERS

Save Panel Space with Two Controlling Pyrometers in One Instrument



You can cut control panel space easily by using the Bailey Pyrotron Temperature Controller. This Potentiometer-Pyrometer can be furnished to record and control two separate temperatures at the same time.

● Each control system is actuated by a thermocouple which is always connected to the self-balancing potentiometer circuit. *Each temperature has its own independent system.*

A comparison of related temperatures can be made quickly as both records are on the same chart.

For details on this unusual thermocouple type Recording Controller ask for Bulletin 232. P-12

Other Unusual Features of Bailey Pyrotron Dual-Temp Controllers

1. Null-balance measuring systems kept in continuous balance by inertia free electronic detectors and motor control systems.
2. Ample power for operation of control and alarm devices provided by reversible slidewire drive motors.
3. Usual Galvanometer replaced by sturdy electronic units.
4. Conversion of thermocouple emf to a-c by saturable core reactors containing no moving parts.
5. Maintenance simplified by easy accessibility and by interchangeable packaged units.
6. Careful leveling or protection against usual vibration not necessary.

BAILEY METER COMPANY

1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

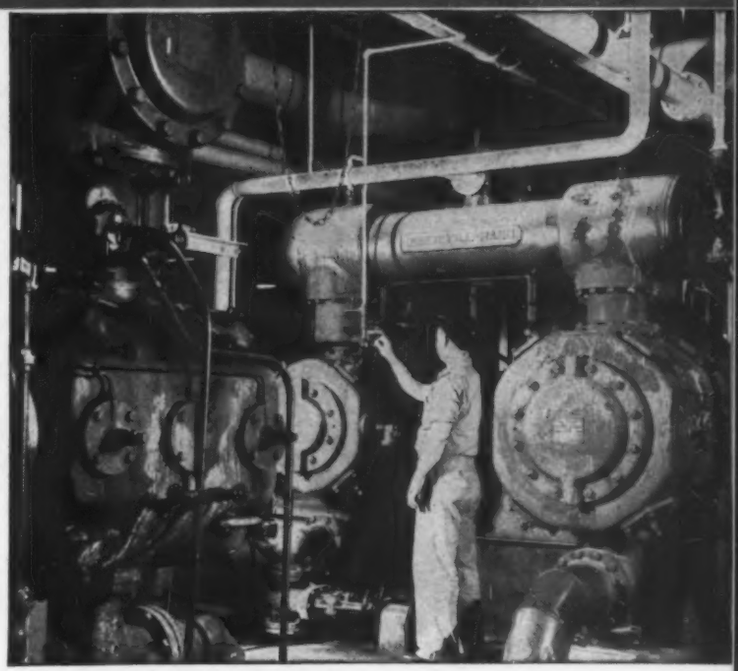
Controls for Processing

TEMPERATURE FLOW
PRESSURE LEVEL
% OXYGEN DENSITY
% COMBUSTIBLES RATIO

DOWELL

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

cooling jacket efficiency restored



Chemical cleaning removes scale —increases power!

Cooling jackets clogged with scale and sludge decrease efficiency, retard power output. To remove these *insulating deposits*, many plant engineers call on Dowell—because they have found the Dowell *chemical* cleaning method to be thorough, economical and rapid.

Dowell engineers fill the equipment with liquid solvents carefully selected for each job—and they bring with them all chemical mixing, heating, pumping, and control equipment required.

For more information on the *chemical* cleaning of compressors, gas engines, diesels—for boilers, condensers, filter beds, blast furnace cooling systems—for water lines, for many types of *heat-exchange equipment*—and for increasing water well output—call the nearest Dowell office.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

New York, Philadelphia, Boston, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Kansas City, Wichita, Oklahoma City, Houston, Fort Worth, Shreveport, Mt. Pleasant, Michigan; Salem, Ill.; Borger, Texas; Wichita Falls, Texas; Midland, Texas; Lafayette, La.
Long Beach, Casper: Dowell Associate—International Cementers, Inc.

Dowell service is supervised by trained engineers using carefully selected solvents and special mobile equipment.

DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

ARE YOU GETTING
MAXIMUM PRODUCTION
FROM YOUR PRESENT EQUIPMENT?

F. E. I.
Equipment

- Direct Fired Cover Furnaces for Annealing, Spheroidizing, Normalizing and Bright Annealing of wire, rods, coiled strip, flat sheets or tin plate.
- Convection Bases especially designed for heavy coil loads, give 200% to 400% longer life.
- Galvanizing, Patenting and Normalizing Furnaces for WIRE, BAR, and TUBE MILLS.
- Galvanizing Furnaces for Pipe, Sheet and Job Plants.
- Soaking Pits

The above cover annealing furnace for sheets in a representative steel plant was converted to our Direct Fired Combustion System and immediately resulted in an increase in production of over 50%, eliminated top stickers and improved metallurgical quality. At the present time every furnace in this department has been converted to our system. We ought to be able to do the same for you.

This increase in production is possible because we have introduced new principles of heat application in the metals producing field. These principles are applicable to the Wire, Rod, Sheet, Strip, Bar and Galvanizing Industries. For applicability of F.E.I. Direct Fired Combustion Systems to your present equipment write, wire or phone for further information.

F.E.I.

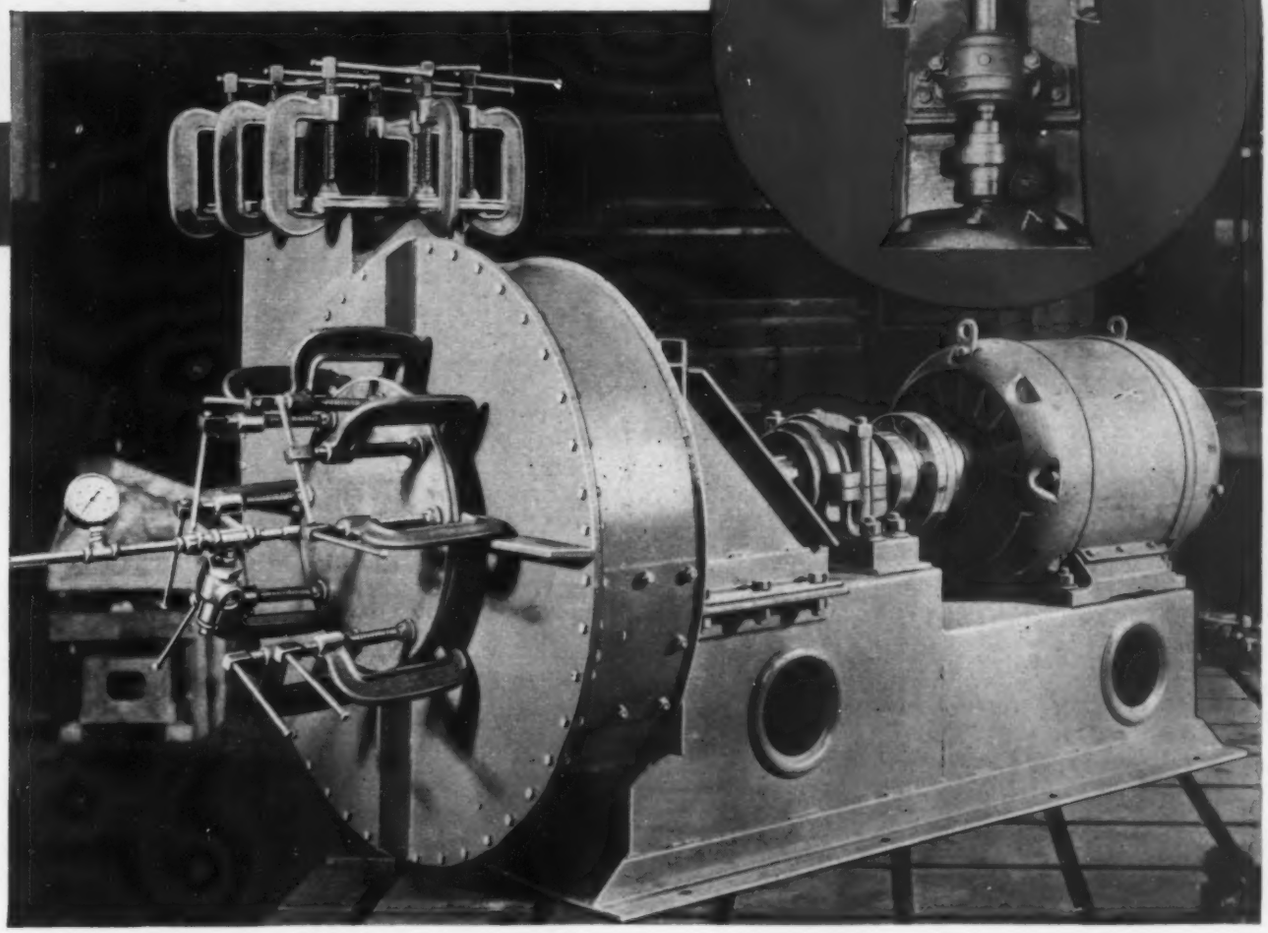
FURNACE ENGINEERS, *Inc.*

FOREIGN REPRESENTATIVES
FOR CANADA: SALEM ENGINEERING (CANADA) LTD.; TORONTO, ONT.
FOR EUROPE, ASIA: SALEM ENGINEERING CO., LTD.,
124 DEVONSHIRE ST., SHEFFIELD 1, ENGLAND.

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

GAS-TIGHT...

RIGHT FOR THE JOB



Shut-off plates are fastened with C-clamps while air pressure in housing is boosted to specified line pressure. Insert shows husky, precision construction of shaft and bearings . . . also gas-tight stuffing box.

Where you have fumes to handle and want to keep them where they belong — a Buffalo Gas Exhauster is the answer to your problem.

Heavy steel plate construction with flanged inlet and outlet connections, stuffing box suitable for the service, and high efficiency Buffalo rotor — such a fan is pressure-tested (as shown above) and leaks, if any detected by soap bubble test. When you secure one of these gas-tight exhausters, it's ready to go to work.
Write us for full information.

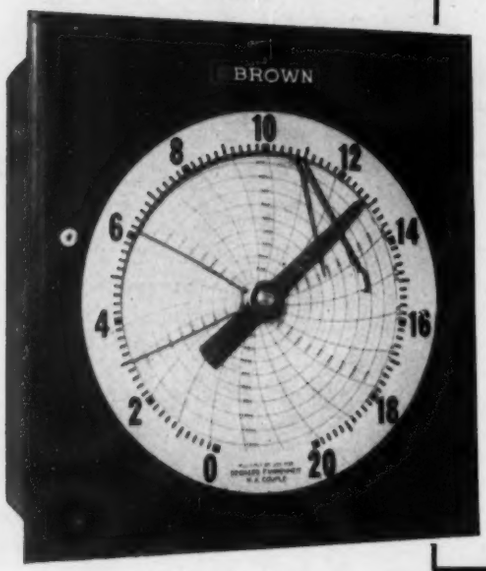
BUFFALO FORGE COMPANY

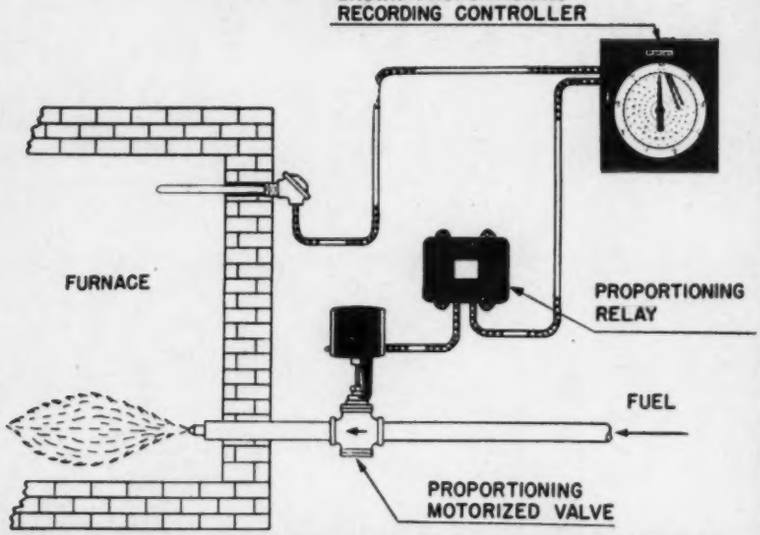
173 MORTIMER STREET BUFFALO, NEW YORK

CANADIAN BLOWER & FORGE CO., LTD., KITCHENER, ONT.

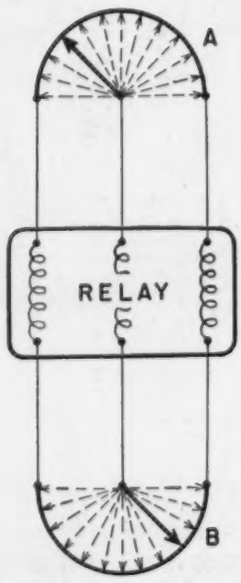
"Buffalo" **FANS for INDUSTRY**

NOW available





PROPORTIONING CONTROL *plus* Continuous Balance



Proportioning Circuit (Pictorial)
ElectroniK Proportioning Controller (A) connected to Proportioning Motor (B)

Now, all the advantages of electric proportioning control are enhanced by the greater accuracy, sensitivity and speed of response of the Brown ElectroniK Potentiometer.

Any application requiring proportioning control certainly needs *continuous balance* measurement — available only in the Brown ElectroniK. Both are needed to do a complete job.

The new Proportioning Control ElectroniK reflects twenty years of experience in electric control design. It incorporates many new and practical features of real value to process control. Smaller increments of valve motion, quicker response and more positive positioning are but a few.

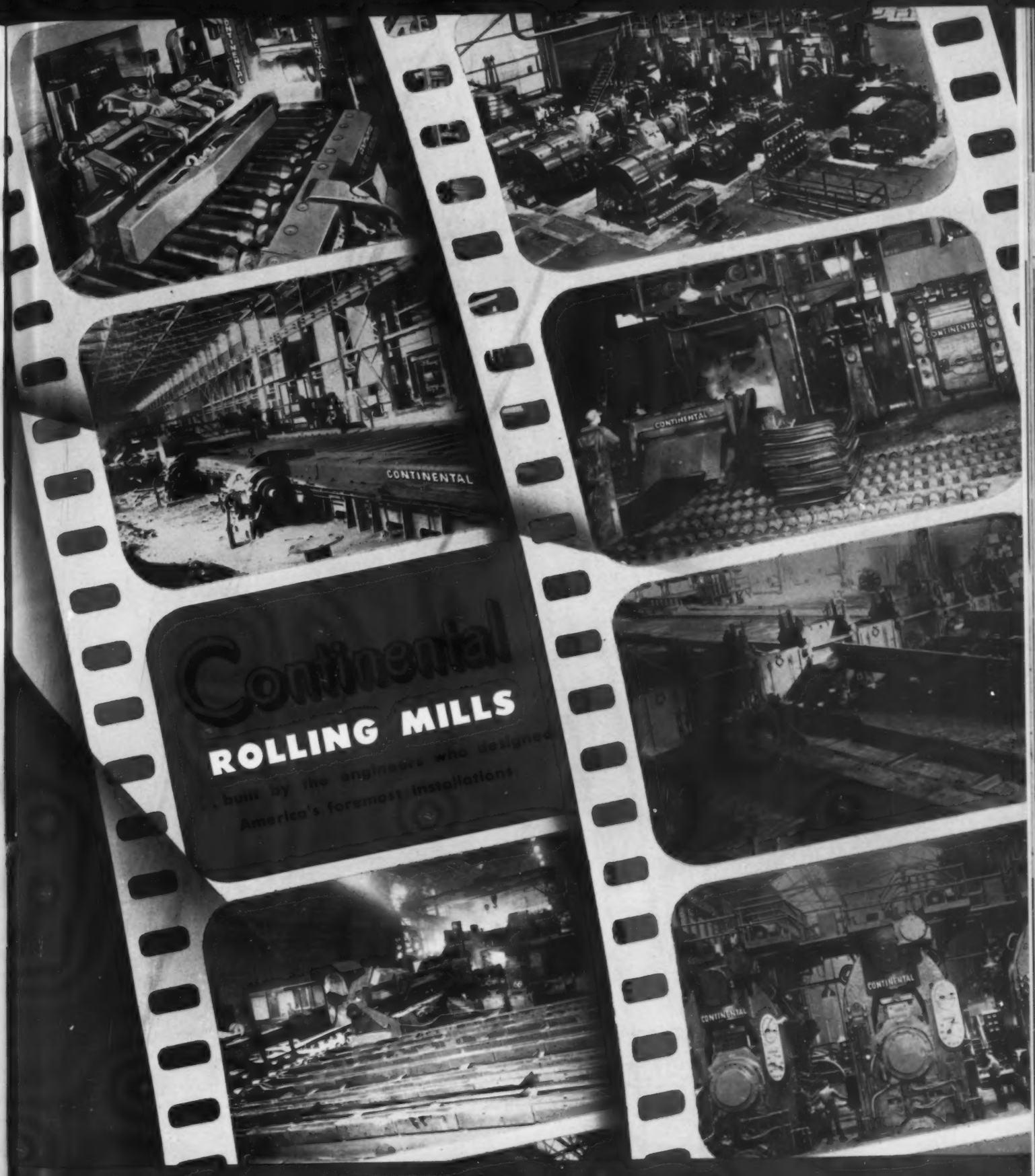
Take the matter of proportioning bands for example. Every instrument is provided with four basic units stepped so as to meet any proportioning band requirement. They slip in and out like a cartridge fuse. What could be more practical?

When you buy the Brown ElectroniK, you get the finest in proportioning controller design.

Write for Catalog completely describing this new instrument. Send for your copy today. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Company, 4464 Wayne Avenue, Philadelphia 44, Pennsylvania. Offices in all principal cities.

TORONTO, CANADA · LONDON, ENGLAND
AMSTERDAM, HOLLAND · BRUSSELS, BELGIUM · STOCKHOLM, SWEDEN

BROWN *Electronik* POTENTIOMETERS



Continental

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FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

at Continental 50 pound or 250,000 pound Castings

. . . are all in a day's work!

Whether it be the "mass" production castings, the "ordinary" type casting or those castings demanding extraordinary skill and experience — CONTINENTAL services and strategically located facilities are ever at your command.

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CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

YOU NEED TO REDUCE THE WEIGHT OF YOUR SETTINGS

FUEL COST PER TON MELTED COULD STAND TRIMMING

POT LIFE SUFFERS FROM HOT SPOTS AND OVERHEATING

put KEMP on your "problem jobs" in tin, lead and salt melting

For example: those who alloy and refine the soft metals want lighter pots for easier tilting and cleaning between melts. KEMP immersion elements can be hoisted out at any time, leaving the pot clear—and all you have to tip is the pot itself, not a ton of brickwork.

For example: any tinplate mill can follow the cue of one of the largest in the East, and cut 40% off its gas bill by switching its stacks from side-firing (through the pot) to KEMP immersion-firing (inside the pot).

For example: heat treaters can minimize chemical attack by molten salt at the liquid line through KEMP pots with stainless steel bands welded in at that point.

And so it goes! The coupon below will put KEMP on the trail of your soft-metal or salt melting problems.

REMEMBER THESE VIRTUES OF KEMP IMMERSION FIRING

1. The pot is heated only by the molten materials. Therefore, the temperature gradient across the pot wall is *down* (not *up*) from the bath temperature.
2. No refractory structures are needed to form a combustion chamber. Light mineral wool insulation around the pot is all that's needed.
3. Spent combustion products are vented down over the bath. They blanket the surface to exclude air (reducing dross) and lower heat losses from the molten surface.

TYPICAL LEAD OR STEREOTYPE POT

PRECISION CARBURETION + ADAPTED COMBUSTION
FOR INDUSTRY'S HEAT-USING PROCESSES
ATMOSPHERE GENERATION & ADSORPTIVE DRYER SYSTEMS
FOR PROCESS CONTROL AND PROTECTION

JMLco K A1 Is

THE C. M. KEMP MFG. CO.
405 E. Oliver St., Baltimore 2, Md.

Send me more information on Kemp immersion-gas-firing. I melt for purposes of: alloying ☐ refining ☐ tinning ☐ patenting ☐ casting ☐ die casting ☐ salt bath treating ☐

..... ☐

NAME .....

POSITION .....

COMPANY .....

PLACE .....

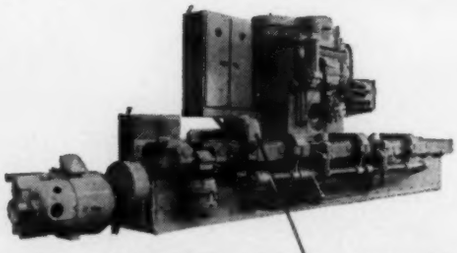
SAVED! TONS OF PRECIOUS SCRAP

..ready for the charging box

There's no "burning up" of valuable scrap in Billeteer-equipped mills. For Bonnot Billeteers thriftily save every ounce of steel removed from billets . . . classified according to analysis . . . ready for the charging box. No other cleaning method permits such efficient salvage of scrap.

One mill, operating four Billeteers, saves over six tons of scrap a day, more than 2000 tons a year. And with Billeteers this mill is often able to salvage billets so badly seamed that hand-chipping or flame-conditioning would be impractical. Let the Billeteer save valuable scrap for you . . . and cut your billetshed operating costs, too. Write for full information.

- CUTS LABOR COSTS
- SPEEDS CHIPPING
- CHIPS 100% RECOVERABLE
- REDUCES BILLET INVENTORY
- SPEEDS CRITICAL DELIVERY
- BOOSTS WORKER EFFICIENCY
- ALWAYS ON THE JOB



Engineered
FOR LOWER OPERATING COSTS
BONNOT
THE BONNOT COMPANY • builders of the BILLETEER • CANTON 2, OHIO

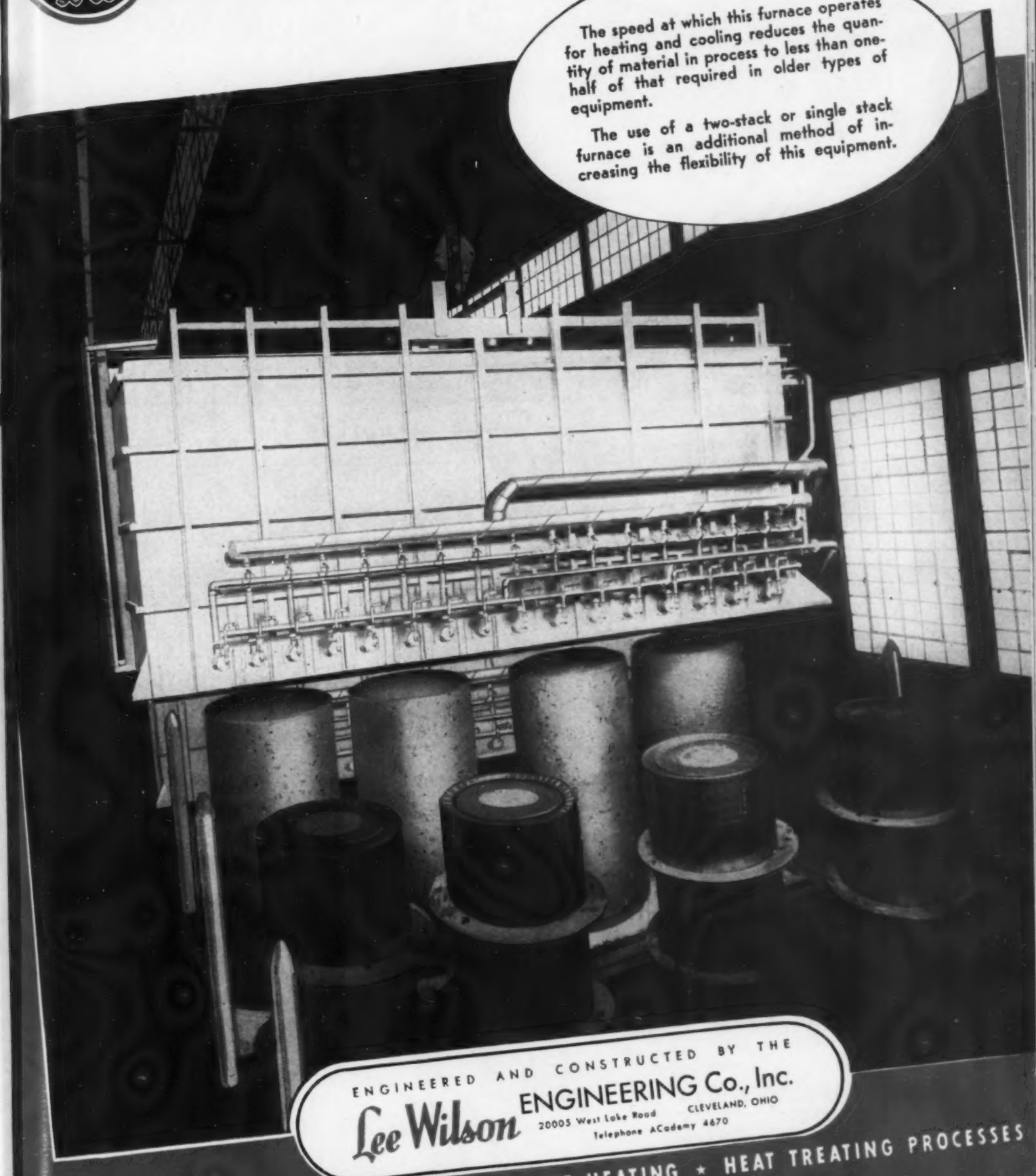
• Bonnot Billet Inspection Tables •
Charging Tables • Cold Saws
Grinding Pans • Clay Mixers
• Clay Feeders, Etc. •

The WILSON RADIANT CONVECTOR FURNACE

is available as a 4-STACK UNIT, 2-STACK UNIT, *or as a* SINGLE STACK UNIT

The speed at which this furnace operates for heating and cooling reduces the quantity of material in process to less than one-half of that required in older types of equipment.

The use of a two-stack or single stack furnace is an additional method of increasing the flexibility of this equipment.



ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

TAKE IT FROM ME— *PAY LOADS... PAY OFF!

PROFITS LIKE THESE WHEN MATERIAL LOADS ARE MECHANIZED ELECTRICALLY

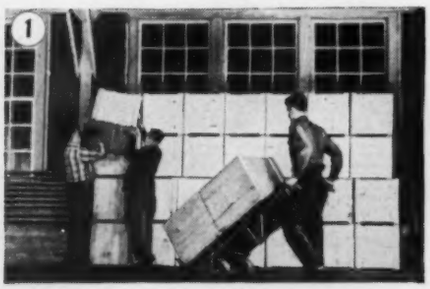
- √ Yearly handling costs cut $40,153.72
- √ 40% increased production
- √ 50% more free storage space
- √ Breakage costs reduced 80%

It used to take *four of our men* eight hours to unload a freight car of raw material MANUALLY. . . *32 man-hours* of back-breaking, gruelling labor. Now, with Automatic Transporter ONE MAN does the same job with ease in just *12 man-hours.*

Labor tugged and strained, moving and storing wood-cased material by hand...ate up *16 man-hours.* Now, ONE MAN operating an Automatic Transtacker, moves, lifts and stacks the same material ceiling high in *one man-hour*... gives us 50% more storage space free.

Yes, since I put these miracle trucks of mechanized power to work for us, production has increased 40%. Our yearly handling costs have been cut $40,153.72 ...dollars and cents proof that a material load MECHANIZED electrically is a PAY LOAD . . . and Automatic PAY LOADS PAY OFF in lightening labor's loads, management's, too!

Give *your* business this chance to make similar savings . . . *pay load profits!* Mail coupon.



1. OLD WAY: Bucket brigade storage system leads to injury of employees, damage to materials. Time for off-piling, hand-loading and unloading truck, and manual storage: 16 man-hours.

2. AUTOMATIC'S WAY: At the warehouse, TRANSTACKER, another new electric money-and-muscle saver, easily lifts, moves and stacks two tons of wood-cased material each trip.

3. OLD WAY: Back-breaking drudgery of man-handling oil drums wastes more productive labor and expensive space, requiring 90 man-hours to unload and store one carload by hand.

4. AUTOMATIC'S WAY: With the SKYLIFT Fork Truck, every trip becomes an easy four-in-one pay load, taking only 4 man-hours to unload freight car and stack drums to the rafters.

Be sure to see ATCO'S new film

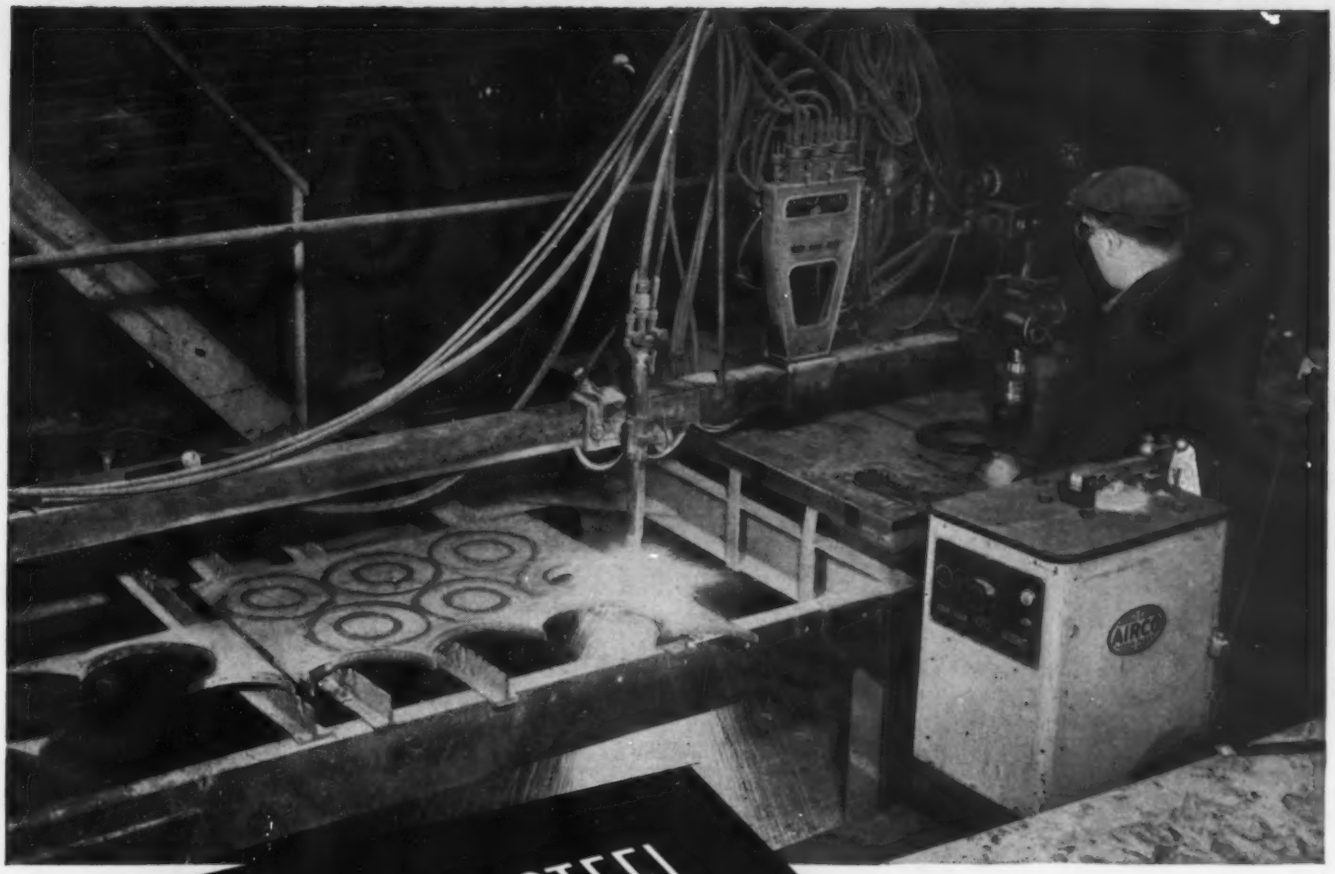
*"PAY LOADS... PAY OFF"

Automatic
ELECTRIC TRUCKS
Lighten LIFE'S LOADS

AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
47 West 87th Street, Dept. D7, Chicago 20, Illinois
☐ Send ihformation on Automatic Electric Trucks.
☐ Have an ATCO Specialist make a free survey of my materials handling costs.
☐ Schedule me for an early showing of ATCO's new movie, "Pay Loads Pay Off."

Company Name .....
By.....Position.....
Street Address.....
City.....State.....

MANUFACTURERS OF THE FAMOUS TRANSPORTER, TRANSTACKER AND SKYLIFT ELECTRIC TRUCKS



cut ⅓ cheaper... and 6 times faster

That is the enthusiastic report on Airco's new Flux-Injection Method of cutting stainless steel at American Fabricators, Inc., of Louisville, Kentucky.

They continued: "We are well satisfied with this Airco process. Cutting #347 stainless, ⅝" thick, we operate at least ⅓ cheaper and 6 times faster than if it were cut mechanically . . . and the operation, at all times, has been very satisfactory."

So say satisfied users from every part of the country. They know the important savings that can be obtained by this new stainless steel cutting technique over the slow, laborious "melting-away" and mechanical processes.

Designed for use with standard Airco oxyacetylene equipment, this new Airco stainless steel cutting method keynotes simplicity, safety and production economy. It brings operating conditions for stainless steel cutting to mild steel ranges, with comparable speeds.

An explanatory article — "Flux-Injection Method Brings Economies of Oxyacetylene Flame Cutting to Stainless Steels" — is available. For your free copy, write: Dept. IS-6142, Air Reduction, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Co., Houston 1, Texas. Represented internationally by Airco Export Corporation.

AIRCO **AIR REDUCTION**

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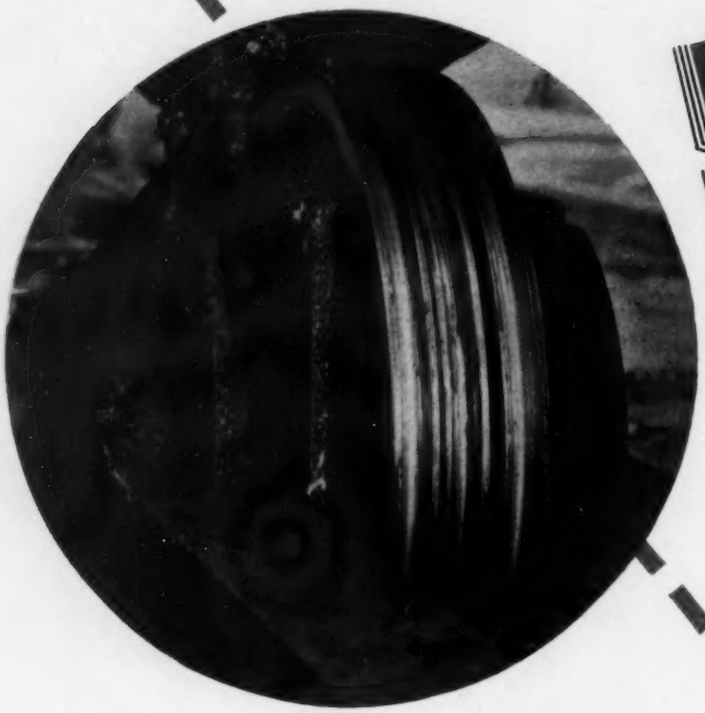
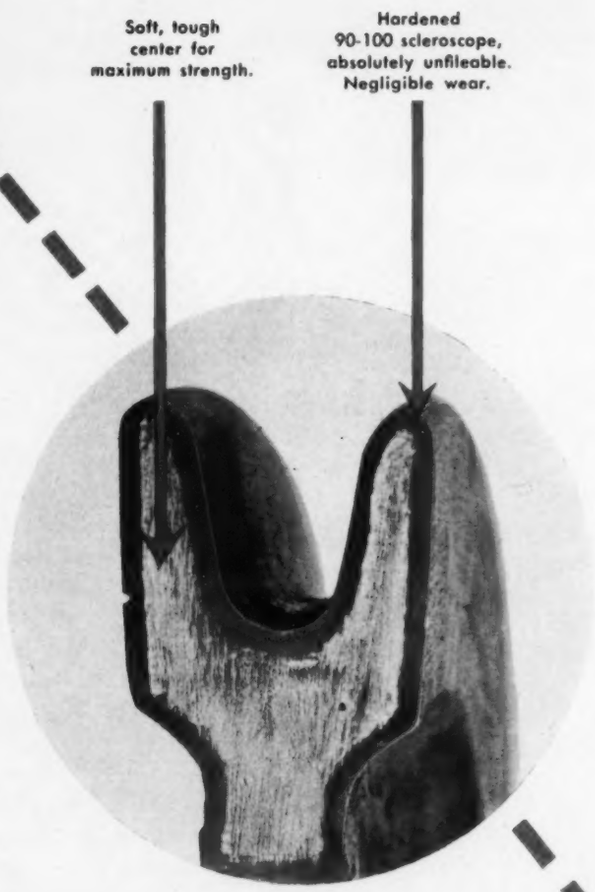
HEADQUARTERS FOR OXYGEN, ACETYLENE, AND OTHER GASES • CARBIDE • GAS WELDING AND CUTTING APPARATUS AND SUPPLIES • ARC WELDERS, ELECTRODES AND ACCESSORIES

"TOOL STEEL" PROCESS SHEAVES are guaranteed to provide



5 TIMES

the life of ordinary sheaves



Right! Our guarantee is backed by a cash refund or material replacement unless "Tool Steel" Sheaves give you:

5 times the life of untreated cast iron or semi-steel sheaves—or 3 times that of high manganese heat treated steel sheaves.

And that's not all! The unfileable surface of "Tool Steel" Sheaves gives your rope a smooth bearing surface which greatly increases rope life.

So, see for yourself how a "Tool Steel" Sheave installation can hoist your profits. Write today for complete information.

ROLLS • GEARS • PINIONS • SPROCKETS • WHEELS
and other TOOL STEEL HARDENED PRODUCTS

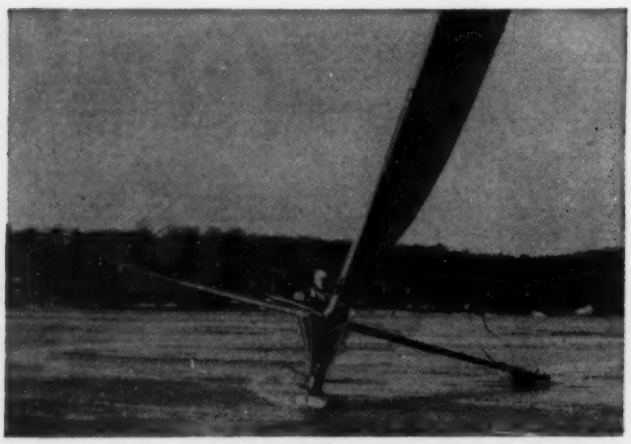
THE TOOL STEEL GEAR & PINION CO.
CINCINNATI 16, OHIO

Another
VACUUM CONVEYOR INSTALLATION
Showing 6" flue dust conveying line including special abrasive-resistant fittings with renewable wearback sections—Recently installed in one prominent Steel Producing Plant in the Ohio Valley.
Our Engineering Service is always ready to discuss and help you solve your problems.
THE VACUUM CONVEYOR COMPANY
MAIN OFFICES: CURREN ARCADE BUILDING, NORRISTOWN, PENNA.
SALES REPRESENTATIVES: PHILADELPHIA, PA. PITTSBURGH, PA. GARY, IND.

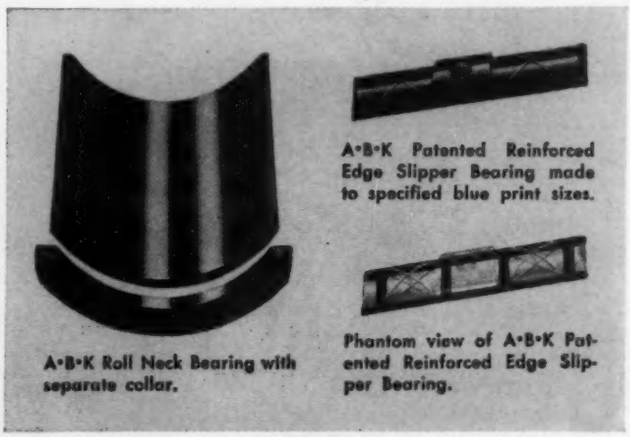
How is production stepped-up with LAMINATED PLASTIC BEARINGS?*

1 **Records kept** by many steel mills show conclusively that production goes up when laminated plastic bearings replace metallic bearings. Why? There are fewer shut-downs for bearing replacement, more productive hours per mill, because . . .

2 **These extremely** durable bearings customarily outwear metal bearings by several times. This means, too, that close tolerances are held with a bare minimum of roll adjustments. Time usually lost is saved. Another important point to you is this . . .



3 **The hard, smooth** surface of laminated plastic bearings has a very low coefficient of friction. Here are substantial power savings and also big savings in grease and oil, as *water* is successfully used for lubrication. For all these outstanding reasons . . .


A·B·K Roll Neck Bearing with separate collar.
A·B·K Patented Reinforced Edge Slipper Bearing made to specified blue print sizes.
Phantom view of A·B·K Patented Reinforced Edge Slipper Bearing.

4 **Always specify** A·B·K Laminated Plastic Bearings. The engineering, research and production facilities of American Brakeblok stand behind these bearings. A test will show how A·B·K Laminated Plastic Bearings up production and cut costs.

5 For full information on A·B·K Laminated Plastic Bearings and their application to your steel mill bearing problems, communicate with American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Michigan.

American Brakeblok

*A·B·K Laminated Plastic Bearings

AMERICAN Brake Shoe COMPANY — AMERICAN BRAKEBLOK DIVISION, DETROIT 9, MICHIGAN

More Steel per hour

...with SUSPENDED BASIC PORT ENDS

...Lower Costs.

Savings from 5 to 15 cents a ton are being made.

...Less Brick Mason Hours.

Downstairs repairs are being made in a fraction of former time.

...Easily Removed Slag.

Cleanout time cut in half because of granular slag.

BASIC OPEN HEARTH LINING

The above view of the port is taken from the pit, looking at the side wall. Notice the increased downtake area.

Upper left—Worm's eye view, looking straight up from the pit. Notice the condition of the tile after two main arch campaigns.

Left—Pieces of granular slag from basic end operation — containing 60 to 80% iron oxide.

M. H. DETRICK CO.

111 West Washington St., Chicago 2, Ill.

No More Downstairs Rebuilds

Two and a half years' operation with Detrick Suspended Basic Ends have demonstrated a new technique for handling downstairs repairs. When a floor job is done, minor repairs can be made downstairs, entirely eliminating a long shut-down for a complete rebuild. This saving in rebuild time is reflected in the total tonnage for the year.

Better scheduling of production to maintain a uniform flow of steel is possible, because downtime is reduced from 2 weeks to less than one week.

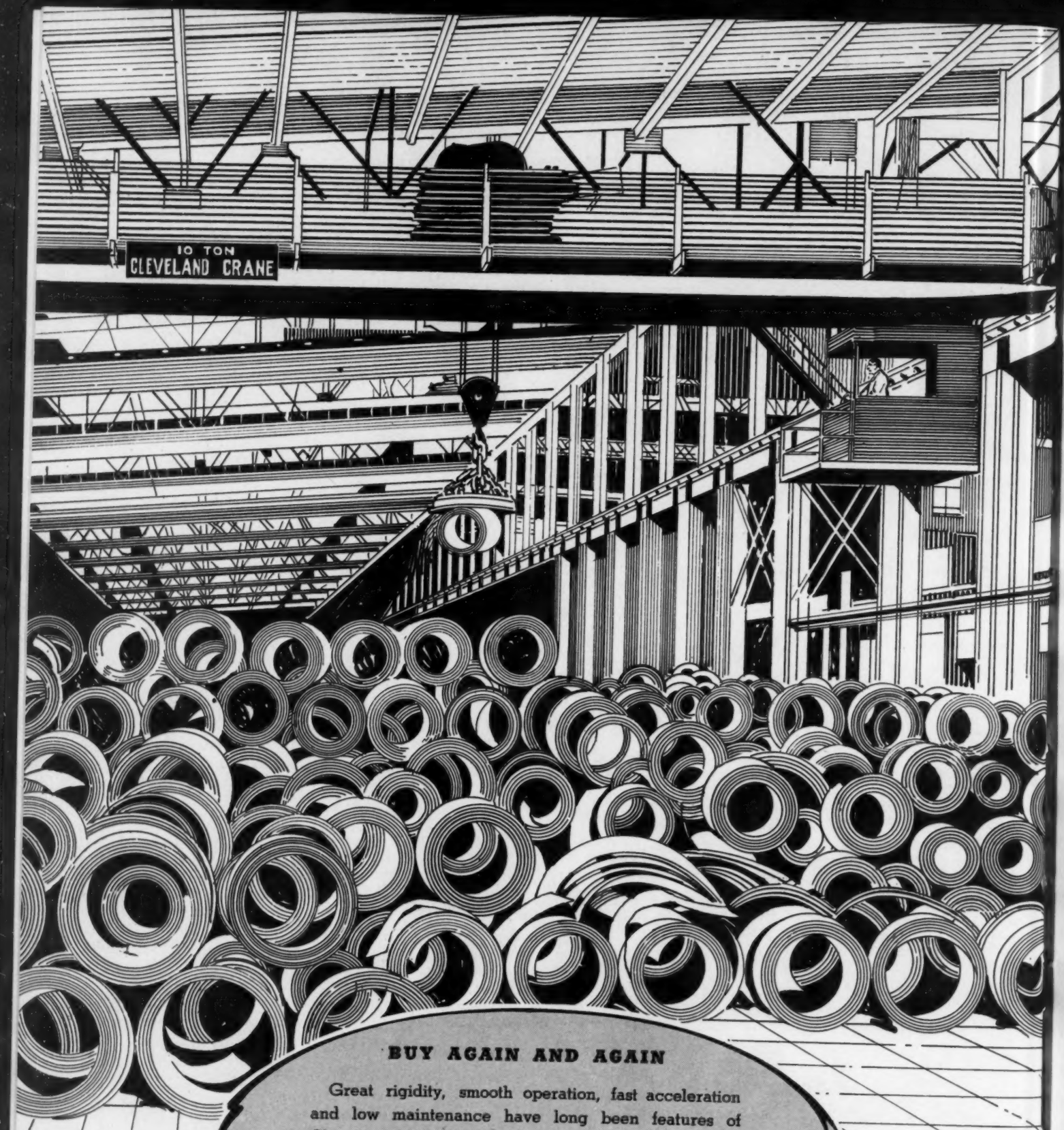
The greatly increased life of the brick saves Brick Mason Hours and cuts brickwork cost-per-ton of steel produced.

Slag is granular like soft coke and can be removed by shoveling into a conveyor or by a power shovel. Because of its iron oxide content it can be returned to the furnace as sinter or direct to the blast furnace.

If it's a problem of enclosing heat it's a job for Detrick!

DETRICK FURNACE ENCLOSURES

USE DETRICK INSULATION ... PLASTIC or BLOCK



BUY AGAIN AND AGAIN

Great rigidity, smooth operation, fast acceleration and low maintenance have long been features of Cleveland Mills Cranes.

No wonder that steel mills all over the world buy Clevelands again and again.

THE CLEVELAND CRANE & ENGINEERING CO.
5002 EAST 289TH ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

IN 1946 the steel industry consumed 43,442,000 gross tons of iron and steel scrap. Of this amount, 20,435,000 tons were purchased and 23,007,000 tons consisted of home scrap.

Scrap prices, which rocketed to figures ranging between $38 and $45 per ton, are already showing some signs of reversing. Attractive prices have led to intensive collection, and have brought out much material which had been held for sale as second-hand parts.

▲

IN many cases, the tight scrap situation has contributed to the black market which is beginning to concern the steel industry. Some scrap dealers will not sell scrap unless they are allowed to purchase some steel, which is then eventually sold at three to six times the prevailing price.

It is also said that some small "war-baby" manufacturing plants, closed down since the end of the war, have been able to continue buying material which is then resold at such prices that the companies are now making larger profits than when in operation.

Incidents of this kind have disturbed steel buyers and are bringing ill-will, even though unmerited, on the steel producers, and they will be wise to do what they can to end such practices.

▲

NOW that we've wound up 1946 income taxes and have nothing to do except look forward to second quarter payments for 1947, we can't help but hope that Uncle Sam will begin living within his income and without most of ours.

▲

AT the risk of sounding like a phonograph record stuck in one groove, we might mention that the January payroll in the iron and steel industry established a new record. Earnings of wage earners and salaried workers totaled $155,778,000. Wage earners worked an average of 40.4 hours per week, at an average of $1.374 per hour. Total employment averaged 601,200, composed of 512,600 wage earners and 88,600 salaried workers.

▲

AN airline advertisement recently made quite a point of the speed of its transportation because a crate, containing two rabbits when shipped, arrived at its destination with two rabbits. To our mind, that proves nothing. As a boy, we kept two rabbits in a pen for three years and still had only two rabbits. P. S. — They were both bucks.

▲

A SURVEY made recently by the Engineers Joint Council covering 104 large industrial employers shows the medium starting salary for engineering graduates to be $207 per month. Five companies reported starting salaries of more than $250, while only four companies reported less than $175. The minimum reported was $150.

▲

IS it true that John L. Lewis' court troubles arise from his contributing to the delinquency of miners?

▲

IN the annual report of National Steel Corporation, E. T. Weir recommends a change in federal tax laws so as to give some recognition to abnormal replacement costs by allowing larger charges for depreciation and depletion. Under existing laws, charges for depreciation and depletion generally can be made only on the basis of the actual cost of facilities. Even if identical replacements were made, costs at today's prices would be much higher than original costs. Actually, technological advances require replacements to be larger, heavier, and therefore more expensive in almost every case.

The report states that National Steel spent over $27,000,000 for property additions in 1946 and that an equal amount is appropriated for 1947 spending.

▲

MEDICAL men report many startling cures through the removal of brass rails that have been pressing against the patients' feet for years.

▲

IN a recent address before the American Society of Tool Engineers, J. F. Lincoln said: "Not only have we removed the domination of management over the workers, but we also have set up unemployment insurance so the worker does not need to work any more. He will be supported by the state without working, practically speaking, as long as he wishes. He may have to do a little foxy fenagling in order to make this true, but it is close enough to being true for all practical purposes. While this arrangement may sound funny to the average individual, it is extremely popular with the majority of voters; hence, it is not going to disappear in a democracy."

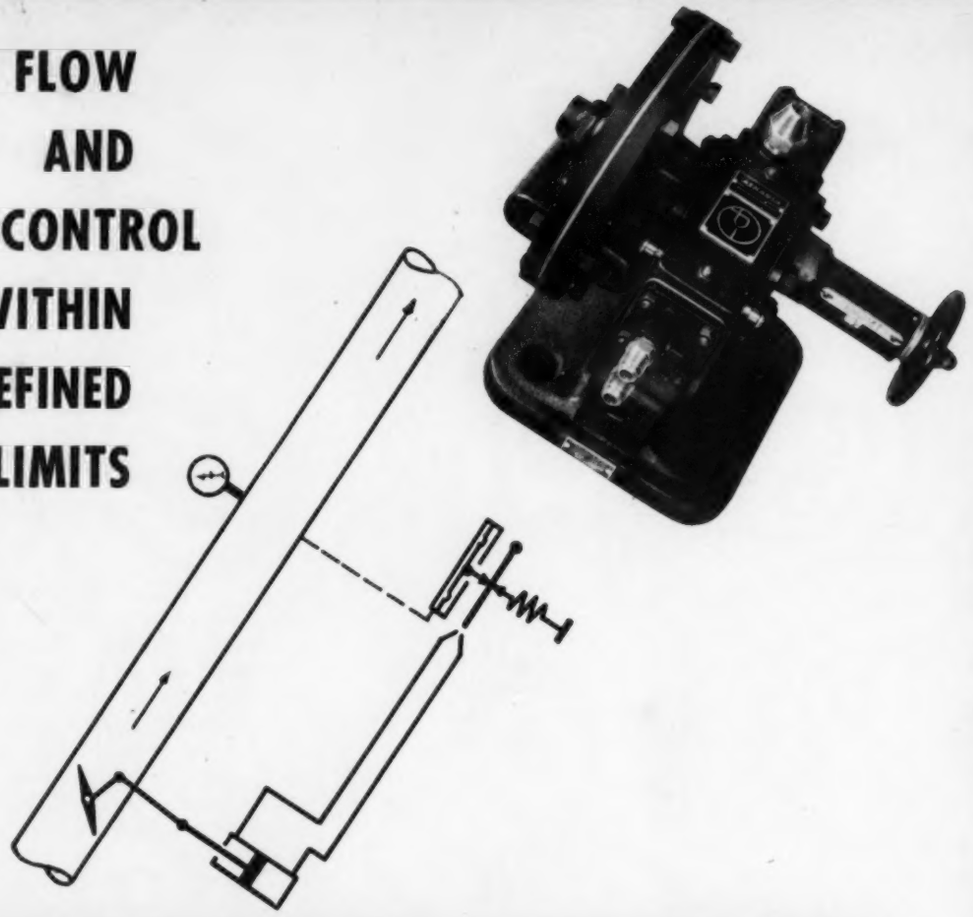
▲

THERE'S a lot of wisdom in old John Ruskin's statement: "He who has truth in his heart need never fear the want of persuasion on his tongue."

▲

IN a recent blast against Secretary of the Interior Krug, John L. Lewis accused him of "brutalizing" the miners. Webster's defines "brutalize" as: 1. To make brutal, unfeeling or inhuman. 2. To treat brutally. Which definition did John have in mind?

MAINTAIN FLOW AND PRESSURE CONTROL WITHIN CLOSELY DEFINED LIMITS



WITH *The Askania Regulator*

If your flow or pressure control systems need ***extreme accuracy***—there is no substitute for the Askania Regulator.

The Askania Regulator, through application of the exclusive JET PIPE principle, will instantly respond to very small changes in operating conditions. For instance, when operating on a maximum of 4" water column it is sensitive to changes ***as small as .0025 inch water column.***

Economical, trouble-free service, even under adverse operating conditions, is assured by the rugged simplicity of the Askania Regulator. Few moving parts, operating under a continuous oil bath, reduce frictional wear to a minimum.

The advantages of the Askania Regulator can very likely be applied to *your* production. Write for Bulletin 100, which gives complete technical details on the Askania Regulator and the JET PIPE Principle.

OTHER ASKANIA EQUIPMENT AVAILABLE FOR THE ACCURATE CONTROL OF FLOW, PRESSURE, SPEED AND CONSISTENCY

ASKANIA *Controls*

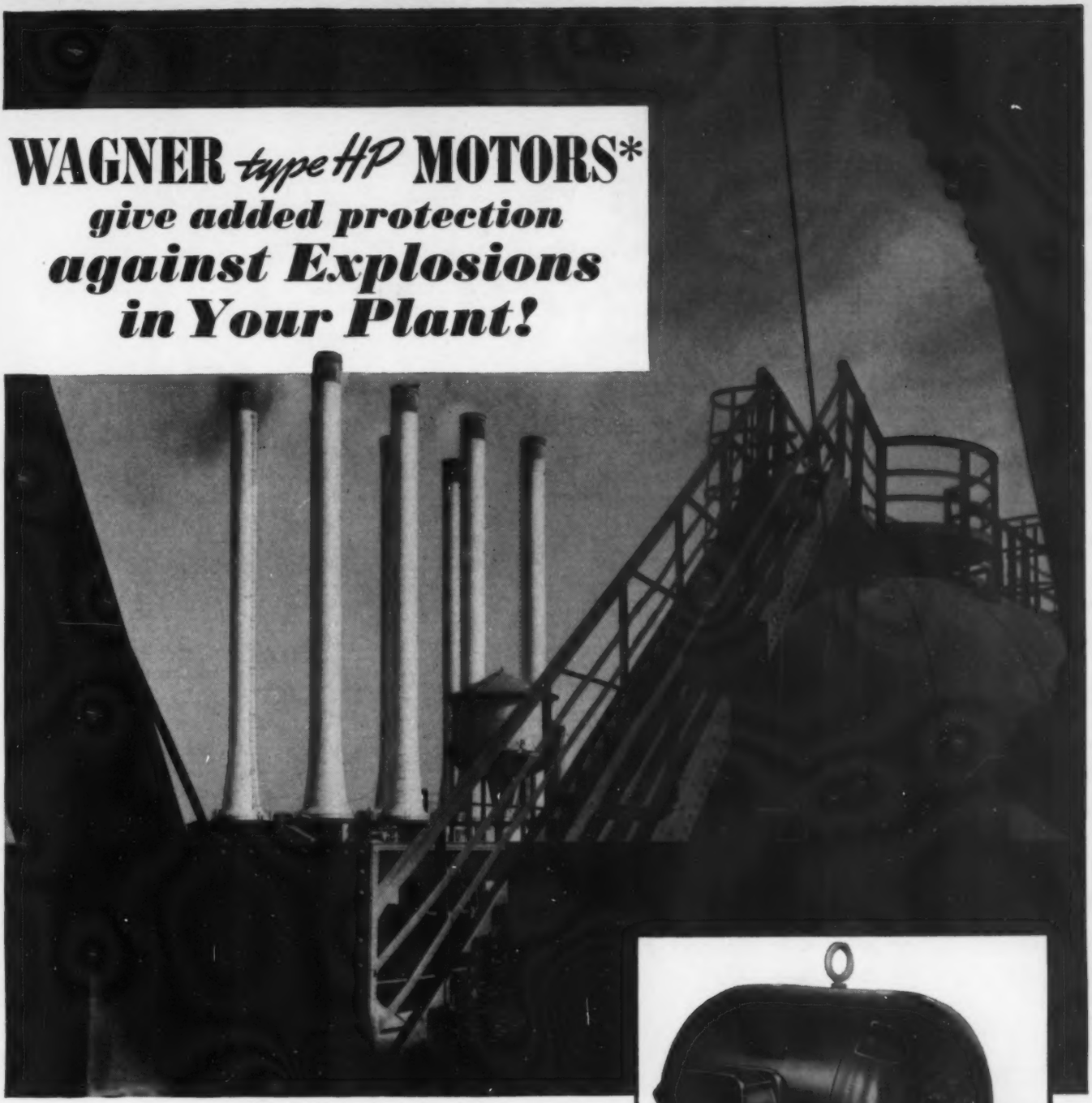
ASKANIA REGULATOR COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

240 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

EXPORT OFFICE FOR LATIN AMERICA—44 WHITEHALL STREET, NEW YORK, N. Y

WAGNER *type HP* MOTORS*
give added protection against Explosions in Your Plant!



In the present period of overburdened production, safety must not be neglected. A costly explosion caused by an improperly protected motor can ruin production schedules . . . injure workers . . . and cause serious losses.

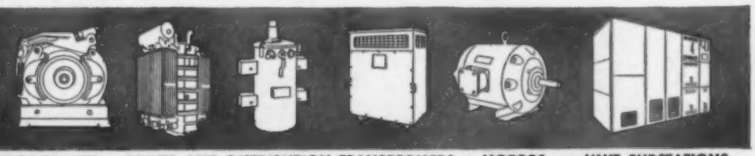
Play Safe—if the atmosphere in your plant contains explosive gases, fumes, vapors, or combustible substances it will pay you to investigate the safety advantages and long life qualities of Wagner Explosion-Proof Motors. Users of Wagner motors also profit by our quick, convenient, nationwide service facilities.

Twenty-nine branch offices, located in principal cities, are at your service to help you in your safety program. A call will bring a trained field engineer, or bulletins on the complete line of Wagner Quality Motors will be sent upon request. Address Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.

*Wagner Explosion-Proof Motor for hazardous-location motor drives.

Wagner Electric Corporation
EST. 1891

Consult Wagner Engineers on all Electric Motor Problems



BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

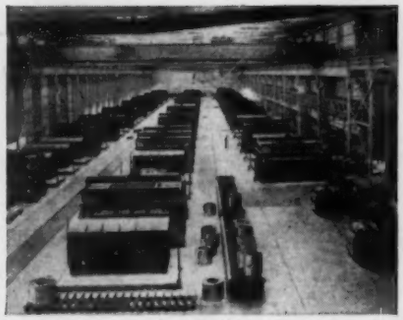
ELECTRICAL AND AUTOMOTIVE PRODUCTS

M47-7

WEAN ENGINEERING Company, Inc.

WARREN, OHIO

Pickling



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Shearing

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- Strip Uncoiling and Automatic Shearing Units
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- Equipment for Chemically Treating Tin Plate
- Automatic Doublers
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- McKay Levelers and Processing Units
- Strip Welding Equipment
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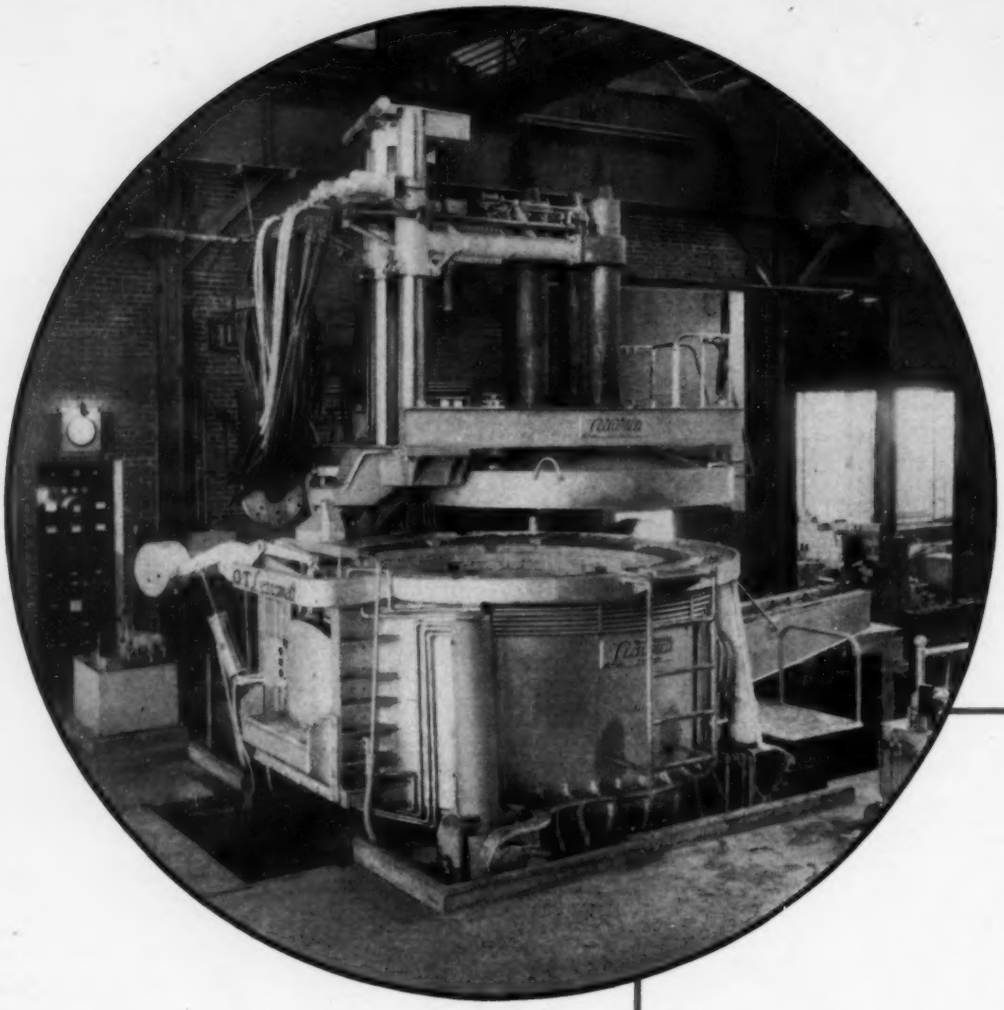

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RECENT IMPROVEMENTS IN COVER ANNEALING

A. J. FISHER

. . . . conversion of annealing covers to a direct firing system at the Sparrows Point plant of Bethlehem Steel Company resulted in increased production and lower fuel and maintenance costs . . . .

By A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

▲ COVER annealing of sheets and tin plate originally started with direct firing, and without the introduction of a prepared atmosphere gas inside the cover. The covers and bases were made up as a portable unit and were so charged into the furnace. This method of annealing had many drawbacks as follows:

1. The weight of the inner cover and bases were, in many cases, more than the weight of the material charged. Since the direct fired furnaces scaled the inner cover rapidly, annealing costs were benefited by making the cover and bases heavy to withstand the scaling effect and subsequent warping. This made for high inner cover and base cost.
2. The excessive weight of the inner cover resulted in high fuel use because of the necessity of heating up so much material weight in proportion to the product charged.
3. Tons per hour were low because of the necessity of not overheating the inner cover, and because of the time necessary to heat its excessive weight.
4. The use of pyrometry to determine actual temperature conditions inside the cover was expensive because of the long portable thermocouple leads which had to extend from the base-cover unit outside the furnace through special openings in the furnace doors or walls.
5. The use of a prepared atmosphere gas was also difficult because of the same conditions as cited above in item 4.

It became mandatory, with the advent of the cold strip mills, to do something about the items as stated above. Accurate metallurgical control of steel temperatures was needed for temper rolling, and the surface was required to be bright and free from heavy scale. The development of the radiant-tube furnace was very timely and solved all of the difficulties in the following manner:

1. The weight of the inner cover was materially reduced in thickness, to values as low as $\frac{3}{16}$ in. Scaling was minimized by the introduction of atmosphere gas

Presented before AISE Annual Convention, Cleveland, Ohio, October 2, 1946.

Figure 1 — This converted direct fired furnace has twenty-six burners per cover.

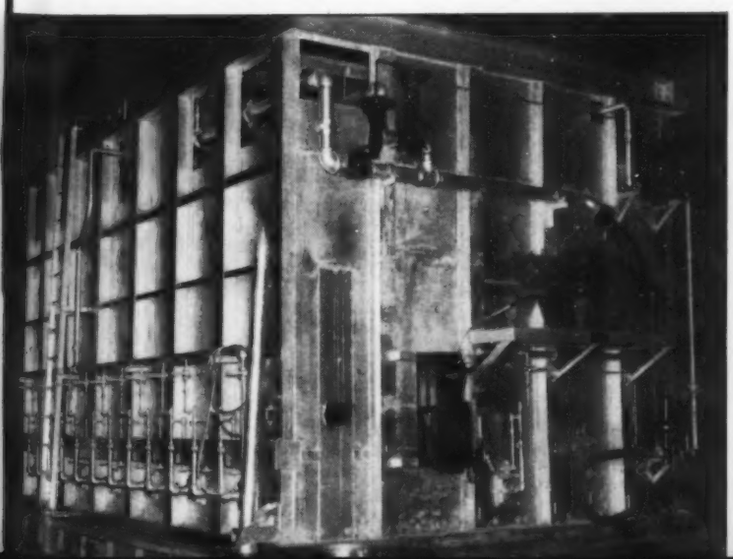


Figure 2 — The gas and air burns in a baffle pocket made of a carbofrax, corrugated, baffle tile.

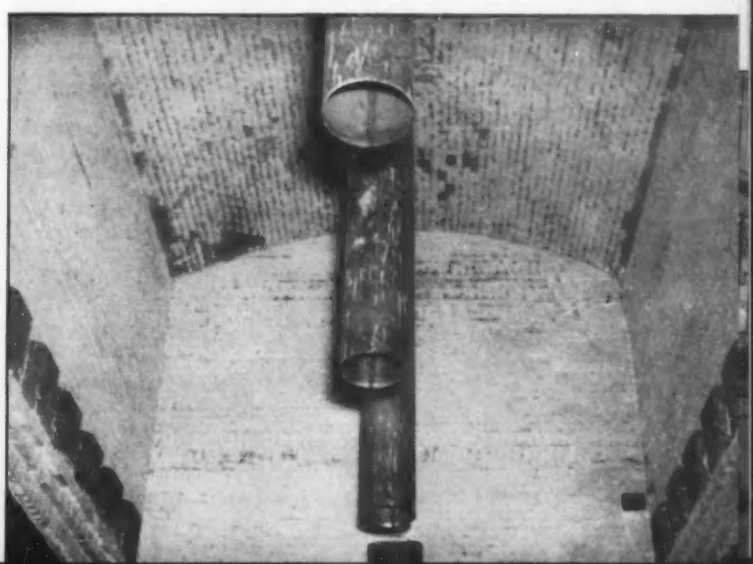
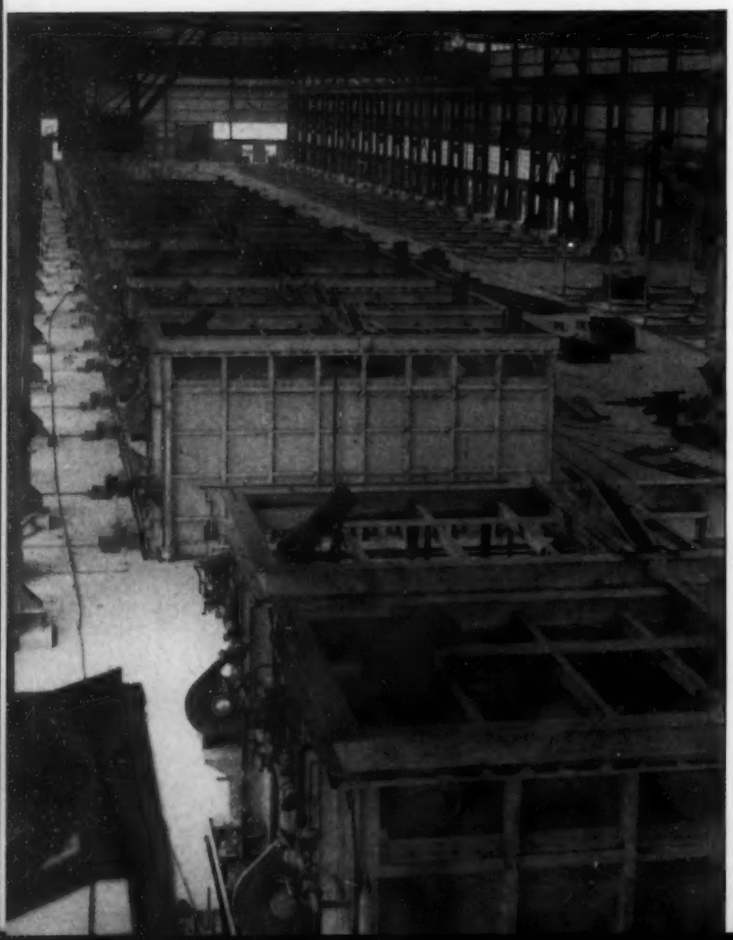


Figure 3 — Top of furnace showing eductors.

inside the inner cover, which leaked through the sand seal and into the space between the inner cover and the radiant tubes. This acted as a protective atmosphere to these covers during the annealing cycle, as long as the radiant tubes were free of holes or cracks. When cracks or holes occurred, the atmosphere in the covers changed from reducing to oxidizing and inner cover life was materially shortened. Therefore, repairs to radiant tubes must be very accurately surveyed and prosecuted. With average maintenance, 3/16 in. inner cover life was extended to 150 to 200 heats before scrapping was necessary. The lightweight inner cover, because of the atmospheric protection it afforded, gave very low maintenance-cost figures.

Figure 4 — This installation is part of a battery of twenty-six new furnaces in the new cold-strip sheet-mill annealing department.



2. The light weight of the inner cover made possible a drastic reduction in fuel and connected gas load requirements. Fuel figures of 1,000,000 Btu per ton and less were quite common.

3. Tons per furnace hour were increased because of the light inner cover construction.

4. The radiant-tube furnace was made portable and the bases fixed. This meant that they could be permanently wired for thermocouples and subsequent automatic control. The regularity of metallurgical duplication was materially enhanced.

5. Because of the fixed base construction, it was also easy to pipe them permanently for prepared atmosphere gas, which made bright annealing of coils and flats easy to accomplish.

After operating radiant-tube furnaces for a number of years, it became apparent that the following disadvantages were inherent and should be studied:

1. The repair costs of the furnaces were between 10 and 22½ cents per ton of product annealed. This was brought about mainly by driving the furnaces hard for tonnage, with subsequent failure of radiant tubes, brackets, braces, supports, etc.

2. The inner cover costs increased materially because of tube failure. This caused the furnace to operate on suction, which induced air through the cover sand seal and subsequently changed the furnace atmosphere from reducing to oxidizing. This cut the inner-cover life to approximately one-half of the life experienced on new radiant tube furnace, or to 75 to 100 heats.

3. Loss of production when furnaces were out of service for repairs.

Because of the above adverse conditions, we at Sparrows Point began to study the use of direct firing for cover annealing. Many advantages were at once seen, provided the inner cover cost could be maintained. Therefore in April 1944, a test furnace was installed and operating data secured. Increase in tonnage and a reduction in fuel and maintenance cost were at once apparent. However, the inner cover life was materially shortened and studies were started on protective coatings for inner covers. The complete development of protective coatings for inner covers will be given later in the report. Suffice to say, protective coatings for inner covers were developed which gave lower inner cover costs per ton with direct firing than those formerly obtained with radiant-tube furnaces. This gave the "all clear" signal for direct firing and conversion from radiant tube to direct firing was started on the twenty-eight furnaces in our tin plate coil-annealing department.

DIRECT FIRED COVERS

A picture of a converted direct fired furnace in the cold-strip tin-mill annealing department is shown in Figure 1. It consists of twelve burners on each side and

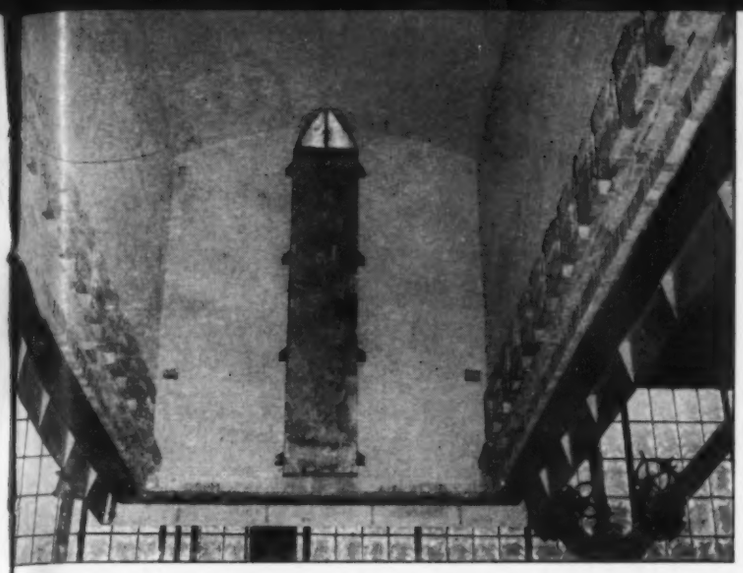


Figure 5 — Flue and burner arrangement on the inside of the furnace.

one on each end, or a total of twenty-six burners per cover. The burner consists of two parts; a luminous and non-luminous section. About 70 per cent of the gas inspirates 100 per cent of the air for combustion by means of inspirators and multijet burners. This gas and air burns in a baffle pocket consisting of a carborundum refractory corrugated baffle tile as shown in Figure 2. Approximately 30 per cent of the gas is forced directly into the top of the chamber which produces a luminous flame. Pressure control of the furnace is maintained by means of three alloy stacks, suspended from the roof between the eight pedestals and inner covers to within about six inches of the sand seal. These stacks are connected to an eductor activated by a compressed-air fan. The eductors are shown on top of the furnace in Figure 3, and the fan in Figure 1. The air from the fan is split between two headers, one for educting the waste gases out of the furnace when on high gas flow, and one for back pressuring the eductor when on low gas flow. The flexible gas-hose connection, gas-pressure regulator, metering orifice and diaphragm gas valve are shown in Figure 1. The control is on-and-off, activated by a three-way solenoid valve in the back of the instrument panel in the control room, which changes the air pressure from 0 to 15 lb, as required. Gas flow to the furnace is determined by the pressure regulator and size of the spuds in the inspirators when on high, and by the gas-pressure regulator and the by-pass orifice around the diaphragm gas valve when on low. The diaphragm air

Figure 6 — Steps in the construction of the eight-pedestal tin-plate coil base.

Figure 7 — Three-pedestal cold-strip, sheet-annealing base.

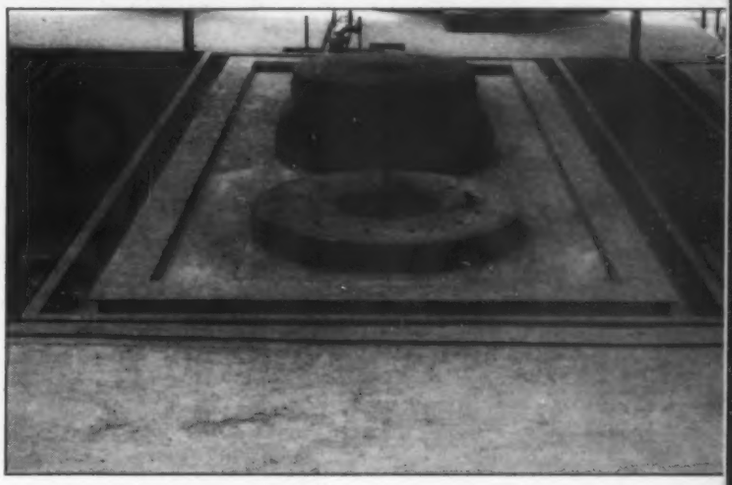


Figure 8 — Construction details of three-pedestal coil base.

valve in the line to the eductor is adjusted to maintain the desired furnace pressure on high, and similarly, the diaphragm air valve in the line to the back-pressure pipe is adjusted to maintain the desired furnace pressure on low. The system may also be operated on modulating control. However, on-and-off control is cheaper and is thought to be the better, since a soaking period is allowed between high and low gas flow which prevents overheating of the coil edges.

Figure 4 shows part of the installation of twenty-six new furnaces for three pedestal bases in our new cold-strip sheet-mill annealing department. In this furnace, the alloy exhaust flues are in the ends of the furnace leading up and out the furnace roof to the eductors.

Figure 9 — This view shows a portion of the eighty new bases, complete and ready for service.

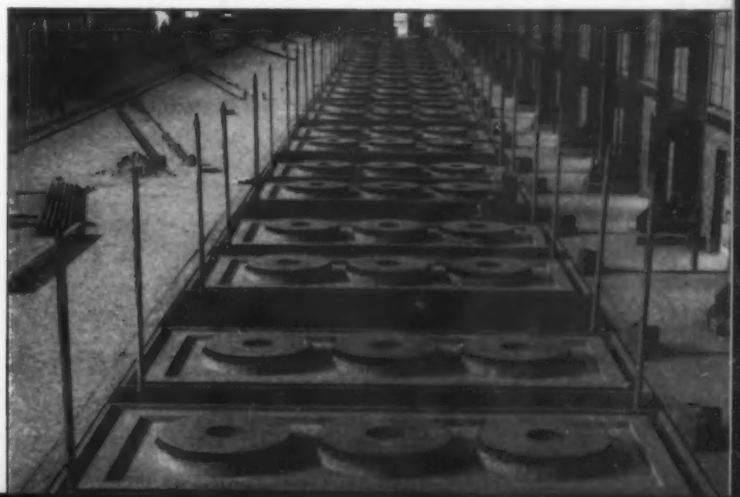


TABLE I

TIN PLATE-COIL ANNEALING DEPARTMENT

Base, 8 Pedestal — 96 in. Piling Height — Inside Diameter, 20 in., Outside Diameter, 51 in.

Step No.	Items	Diam fan - in.	Tons charged	Furnace temp	Steel temp	Time to temp	Soaking time	Cooling time	Total time	Tons per furnace hour	Btu per ton
1	Radiant tube	11½	130	1375	1230	34	10	76	120	2.95	1,076,000
2	Direct fired	11½	137	1350	1220	32	8	70	110	3.42	788,000
3	Direct fired	18	135	1350	1200	22	8	48	78	4.50	697,000
	Per cent reduction	....	....	....	....	35.3	20.0	36.9	35.0	.....	35.2
	Per cent increase	....	....	....	....	....	....	....	....	52.5	.....

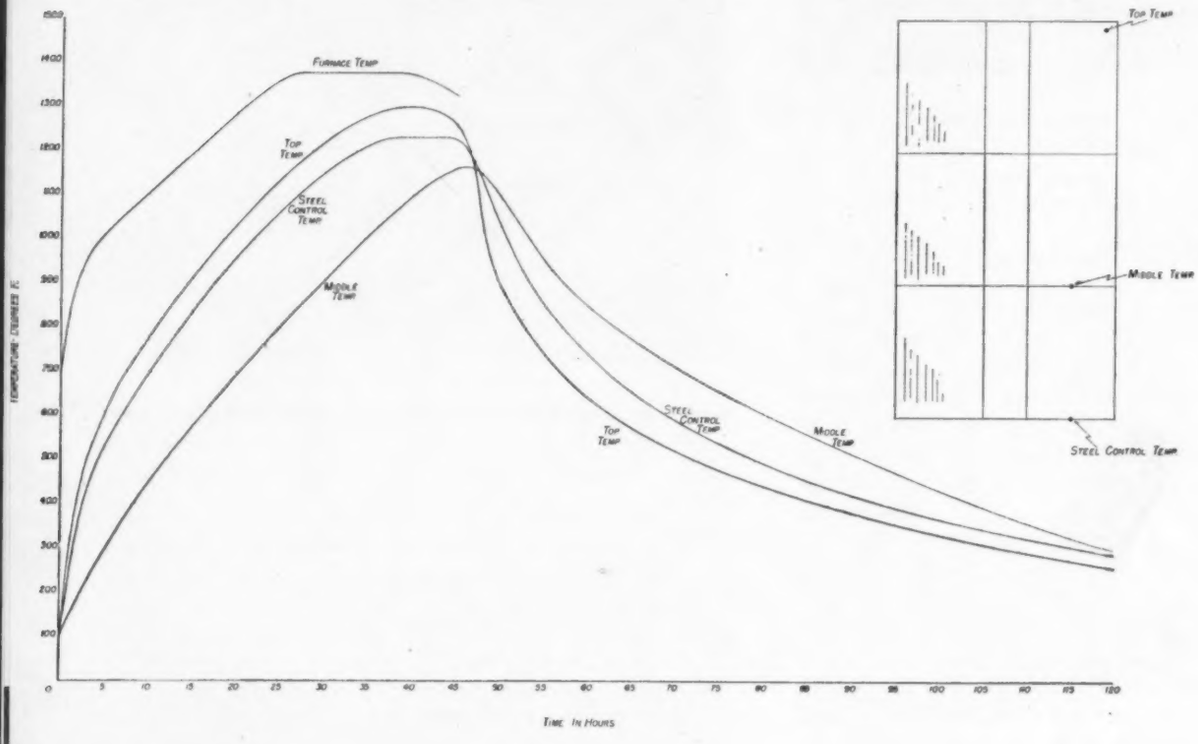


Figure 10 — Time-temperature curve for radiant tube annealing furnace, 8 pedestal base, 96 in. piling height, 11½ in. fans.

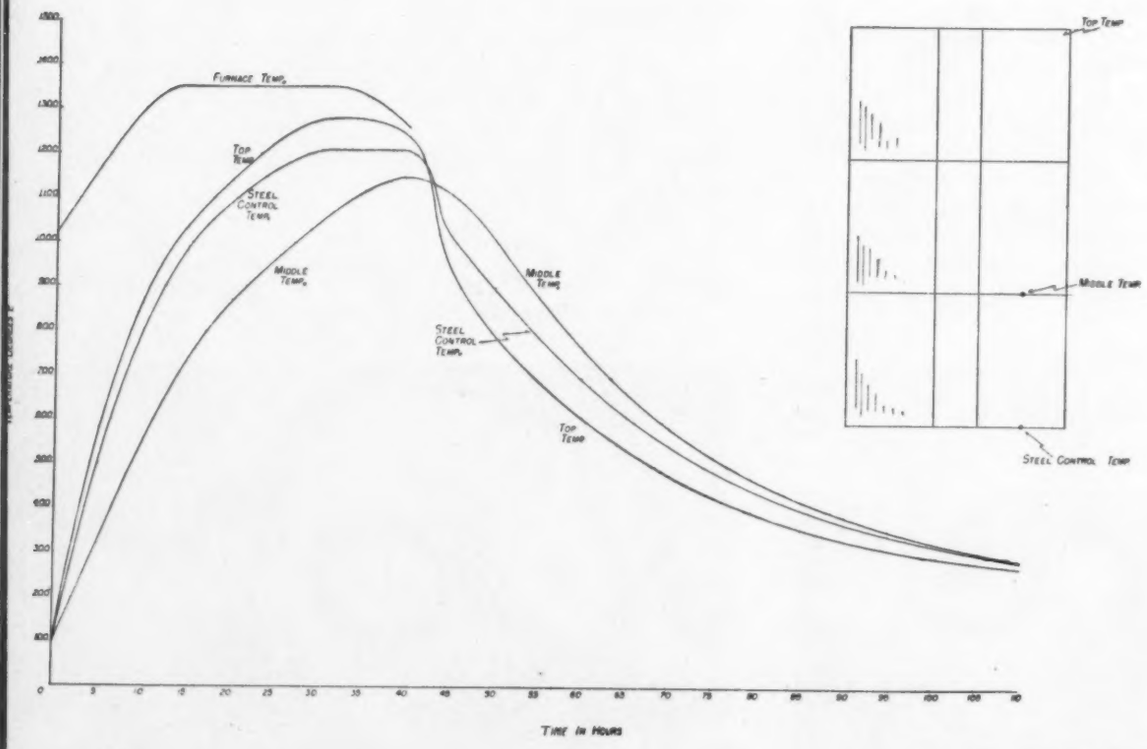


Figure 11 — Time-temperature curve for direct fired annealing furnace, 8 pedestal base, 96 in. piling height, 11½ in. fans.

Figure 5 shows the alloy flue and burner arrangement on the inside of the furnace.

All furnace annealing buildings are separated from other mill buildings by an open air space. The roofs of the buildings are monitored with Stevens ventilators and the eductors to the furnaces are all directed upward toward these exhaust monitors. Due to this natural draft no difficulty is encountered with exhaust fumes at floor level even though coke oven gas containing over 400 grains of sulphur per 100 cubic foot is used. An air trough is provided on the crane cab side of the building and the crane cab ventilation is accomplished by means of an inlet into this fresh air trough, providing fresh cold air in the summer and fresh heated air in the winter.

COIL CONVECTION AND FLAT SHEET BASES

It has always been a problem to design a good coil base that will give abundant circulation and hold its shape when loaded with a stack of three or four tin plate coils. Such a base has been designed at Sparrows Point. It is very strong and has held its shape during four years of continuous operation. Recently, this base has been improved to include 18-inch axi-flow fans.

Figure 6 shows patented eight-pedestal tin plate coil base under construction. Due to the height of the annealing building, the piling height on this base is limited to 96 inches for coils of 20-inch inside diameter and 51-inch maximum outside diameter. Each pedestal is composed of a 1 hp, 1750 rpm motor, 18 in. axi-flow fan, fan-housing casting, two refractory segment rings, centering bell casting, lower doughnut plate, cast grids, and upper doughnut plate with centering ring casting. The base is laid up with nine inches of insulating fire brick between pedestals over which is laid four inches of sand. Eighty such bases are in operation in our cold-strip tin-mill annealing department. Three bases are used in connection with each furnace which are operated as a unit.

Figures 7 and 8 show construction details for a three pedestal cold-strip sheet-annealing department base. This base is designed for 112-inch piling height, 20-inch inside diameter, and 72-inch maximum outside diameter coils. Figure 9 shows part of the eighty new bases complete and ready for service, except for placing the sand around the pedestals.

The performance of these bases with radiant tube and direct fired furnaces in our cold-strip tin mill is shown in Table I. The practice includes radiant-tube furnaces with 11½-inch pedestal fans, direct fired furnaces with 11½-inch pedestal fans, and direct fired furnaces with 18-inch pedestal fans. The maximum amount of gas possible to burn on the radiant-tube furnaces was 7500 cubic foot per hour of 500 Btu gas, whereas the direct fired furnaces operate at 8300 cubic foot per hour.

It is believed that considerable improvement could still be realized by operating the direct fired furnaces at 10,000 cu ft of gas per hour and by using coil spacers to increase the edge heating. With this type of heating, the annealing rate could very easily be increased to an average of 6.0 tons per hour. Arrangements for such a test are now being made.

Composite time-temperature curves of radiant-tube furnaces and bases using 11½-inch fans are shown in Figure 10. Figure 11 shows the same relations for direct fired furnaces and bases using 11½-inch fans; while Figure 12 represents direct firing and 18-inch axi-flow fans. The progressive shortening of the heating and cooling cycles is at once apparent. Figure 13 shows the sections of Figures 12, 13, 14 above 1000 F. These sections of the curves have to do with metallurgical uniformity which shows up considerably in favor of direct fired furnaces and 18 in. fans.

The results of Rockwell hardness tests using the direct fired covers on the new eight pedestal bases with 18-inch axi-flow fans are shown in Table II.

INNER COVER PROTECTIVE COATINGS

Improvement in inner cover design has been divided into two parts: first, the physical design of the cover itself; and second, the surface treatment or protective coating.

We have found that ¼ in. side walls on inner covers are to be preferred over ⅜ in. walls. The welding can be horizontal or vertical as shop conditions dictate. There should be two lifting lugs of alloy steel welded to the inner cover on opposite sides, about 18 in. below the head. The head should be of the oval dished type with rolled-down edge. This cover, by trial, has stood up best of the many designs tried without surface treatment.

The 54-in. diameter cold-strip tin-mill annealing inner covers cost $92.00 each and last 90 heats on direct firing before being scrapped, or $1.02 per heat. To prolong this life we are installing a central station inner-cover treatment plant for our tin mill, sheet mill, and hot strip mill annealing departments. All covers will be treated, and repaired and treated in this plant. Two treatments are now being considered as follows:

Treatment No. 1 — This treatment consists of grit blasting all the mill scale off the outside of the cover, spraying it with 0.007 inches of aluminum by means of metallic sprays, coating it by brush with silicate of soda, and heat treating it at 1600 F for ten minutes before placing it in service.

This treatment will cost approximately $25.00 per inner cover and will extend the life from 90 heats to 250 heats, giving an inner cover cost of $0.47 per heat.

The cover is not treated on the inside, since the surface is protected by the atmosphere gas during the annealing cycle.

Treatment No. 2 — This consists of grit blasting the outside of the inner cover and coating the inner cover as specified in treatment No. 1 on the top of the dished heat and up the side wall 18 inches from the bottom. The intervening space is then metal sprayed with "Metcolizing" process No. 45. This is composed of one 0.015-inch layer of a nickel-chrome alloy and an outer layer of 0.004 inches of aluminum, after which "Metco" seal is brushed on. The cover must then be heat treated at 1600 F for ten minutes. This treatment will cost approximately $185 per inner cover and will extend the life from 90 heats to 500 or more heats, giving an inner cover cost of $0.55 per heat. We have inner covers treated by this method which have completed more than 100 heats with no apparent change or wear.

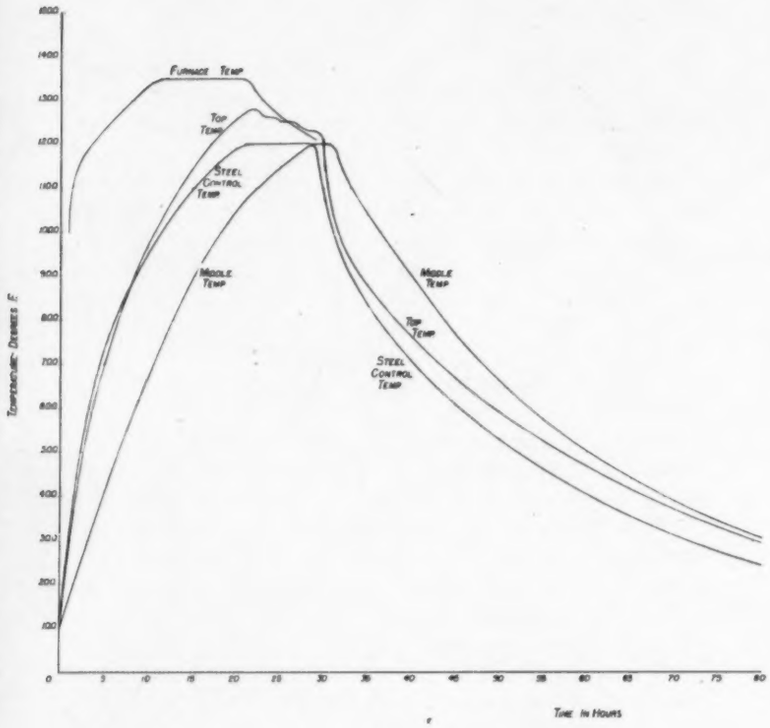
Figure 14 shows an eight-pedestal base with treated

TABLE II

ROCKWELL HARDNESS

Direct Fired Furnaces, 18 in. Base Fans, Rimmed Steel

Position in coil	Pedestal Number															
	1		2		3		4		5		6		7		8	
	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside	Outside	Inside
Top	47.0	52.5	48.0	48.5	40.0	44.5	42.5	45.5	43.0	47.0	43.0	49.5	46.0	48.0	40.5	47.0
Middle	41.5	46.0	48.5	51.0	44.0	47.0	46.0	49.5	46.0	50.0	47.0	49.5	45.0	49.0	48.0	52.0
Bottom	49.0	52.5	48.5	49.5	46.0	49.0	47.0	50.0	47.0	50.0	48.5	48.5	48.0	49.5	47.5	49.5



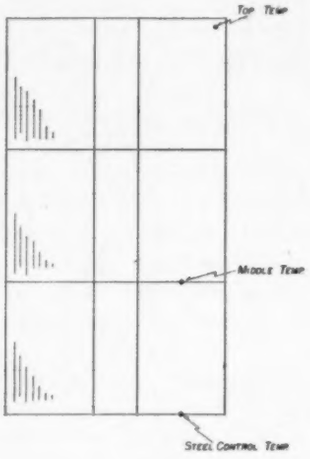
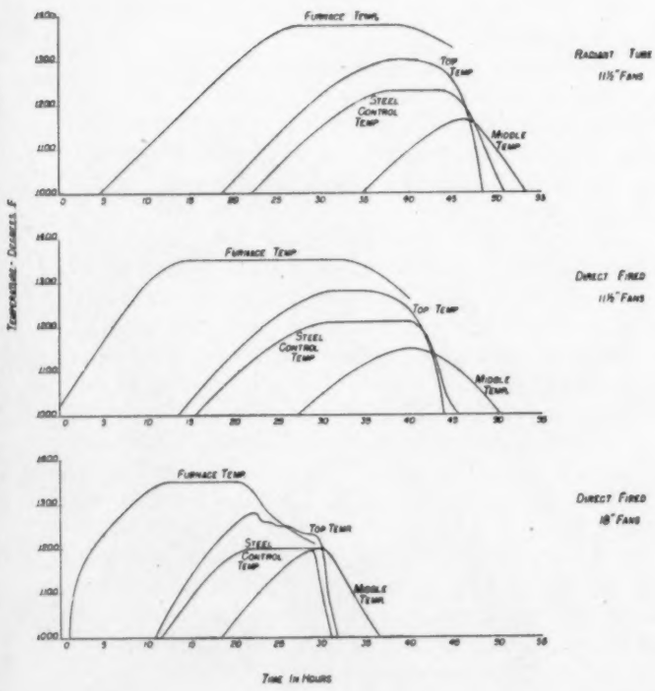


Figure 12 — Time-temperature curve for direct fired annealing furnace, 8 pedestal base, 96 in. piling height, 18 in. fans.



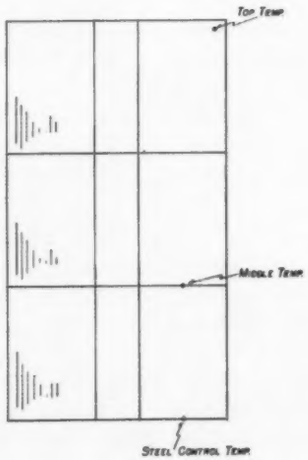


Figure 13 — The portion of the time-temperature curves above 1000 F indicates that the direct fired furnace with the 18 in. fan should give the most uniform steel.

Figure 14 — Treating the inner covers normally eliminates the scale met in the sand seals.

inner covers. The treatment, reading left to right, is No. 1, No. 1, No. 2, No. 1, No. 2.

Treated inner covers eliminate the scale ordinarily encountered in the sand seals. This makes for better sealing and saves screening costs.

INSTRUMENTATION

Two thermocouples are used in the eight-pedestal bases, with one thermocouple on two of the diagonal or opposing bases of the middle four pedestals. Each thermocouple is complete with stuffing box, weight load, and hand grips. Such an arrangement is shown in Figure 15. The couple is retracted during unloading and loading and is released during operation when it is held firmly against the lower edges of the coil. The thermocouple is of the pencil type using iron-constantan wire.

In the three-pedestal sheet-mill bases, three thermocouples are used, one on each pedestal.

Each direct fired furnace is equipped with one alloy-protected iron-constantan thermocouple hanging down from the roof.

The base couples and furnace couples lead into the instrument room panel board and are wired to plug switches. Any thermocouple in any of three bases, including the furnace couple, can be plugged into a recorder and, or, a recorder controller type of pyrometer. Figure 16 shows two sets of these instruments. The left

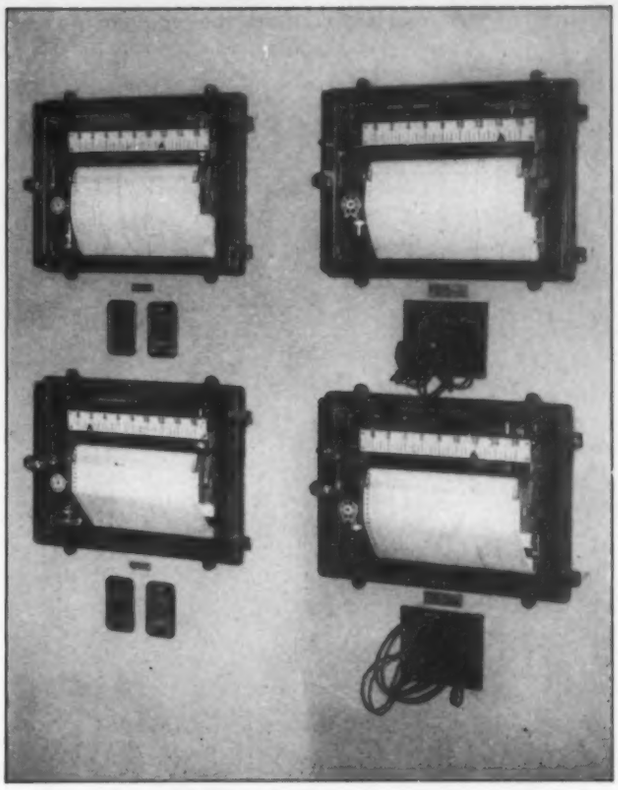


Figure 16 — On the left are the recorders and on the right are the recorder controllers of the pyrometers for the furnace and base couples.

Figure 15 — The thermocouple is retracted during loading and unloading by a lever mechanism.

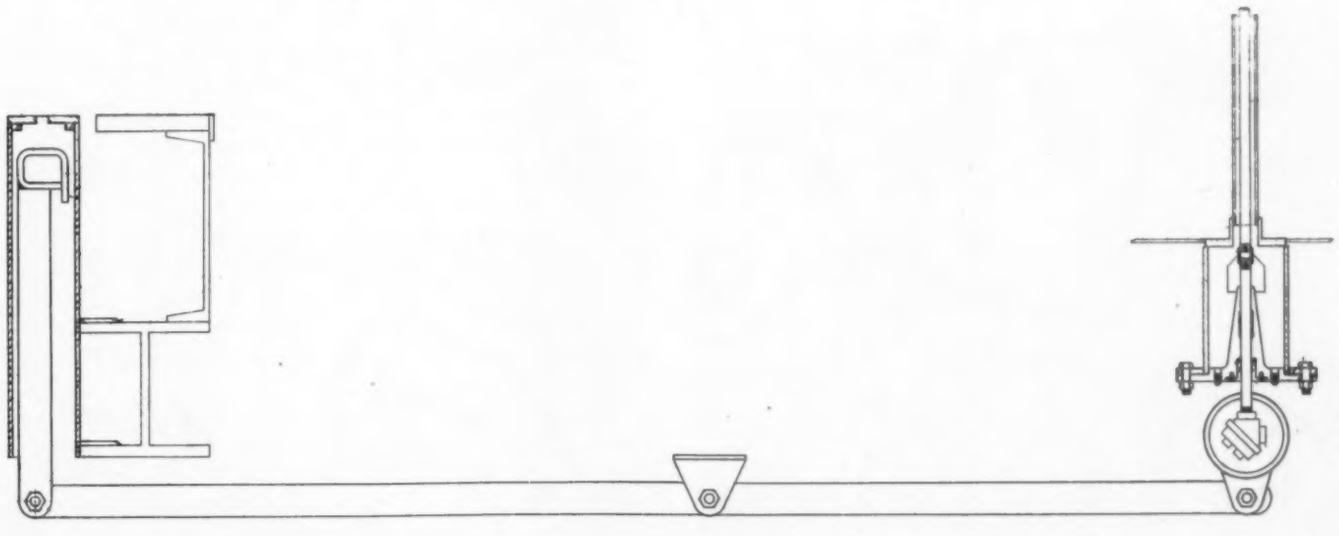
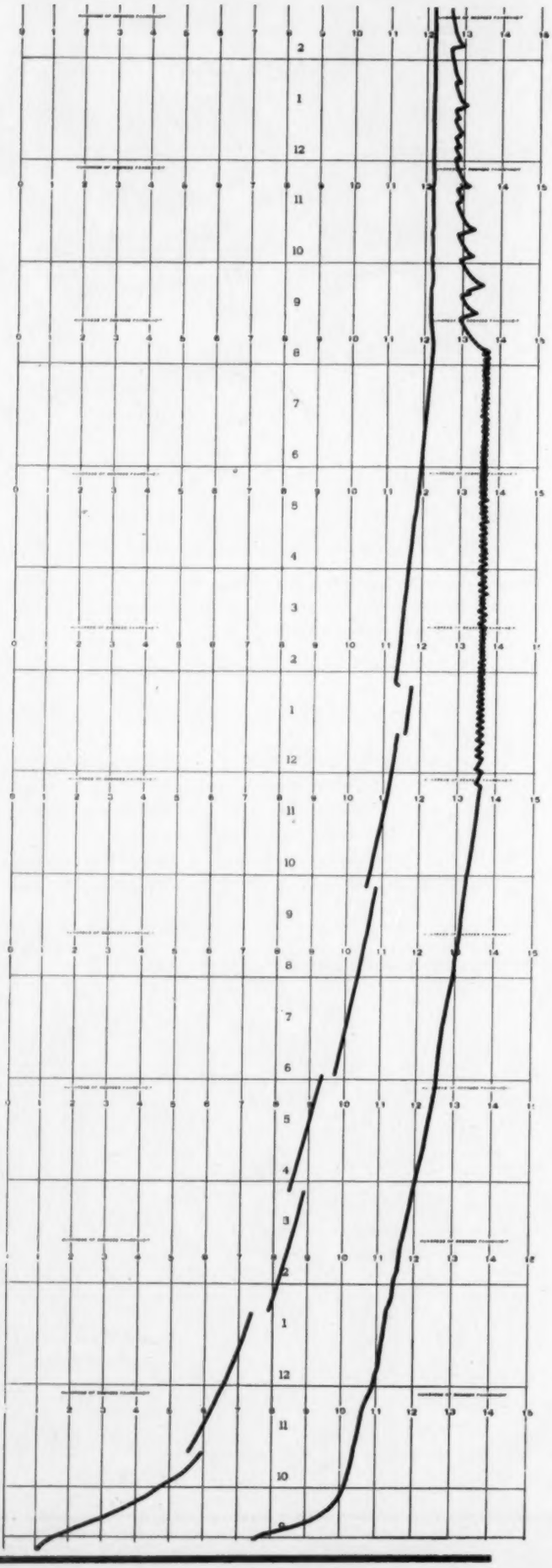


Figure 17 — On the right is shown the temperature record of the furnace temperature, and on the left is the record of the steel temperature which lags the furnace temperature.



instruments are the recorders, the right ones the recorder controllers.

Figure 17 shows a record of the recorder controller. This is a two-print instrument in which both furnace and base couples are recorded and controlled. The furnace couple reaches the set control point first, right-hand curve, and is held by on-and-off control at the required temperature. The steel temperature lags and is controlled when it reaches the desired point, thereby cooling the furnace down below its regulated maximum temperature.

Figure 18 shows the instrument panel of the cold-strip tin-mill annealing department. This room is larger than shown and has space for four desks and a working table.

PREPARED ATMOSPHERES

Aside from metallurgical considerations, the surface condition of the strip is most important. This is particularly the case with tin plate products. Prepared atmospheres have much to do with bright annealing, carbon edges, and corrosion resistance.

We have designed a central station atmosphere gas plant at Sparrows Point to supply gas to our tin mill, sheet mill, and hot strip mill annealing departments. Basically the plant consists of the four 50,000 cu ft hr units as follows:

1. *Wet sulphur removal* — Coke oven gas is used when sulphur is over 400 grains per 100 cubic ft. This sulphur is removed by means of three beryl saddle sodium-carbonate towers equipped with air revivification. The sulphur is reduced to a trace in these towers. The bottom of the towers is shown in Figure 19 and the top of the towers in Figure 20.
2. *Carburetion* — The gas then goes to the proportioning carburetors, is mixed with air, boosted to 24 oz pressure and then passed through a master fire check. This equipment is shown in Figure 21.
3. *Cracking chamber* — The gas then passes through individual fire checks, burners, and into the cracking chambers as shown in Figure 22. The cracking chambers are well insulated and are not water cooled.
4. *Primary cooling* — Figure 23 shows a combined view of the cracking chambers (right to left) and beryl saddle cooling towers. Water is recirculated in these towers by means of heat exchangers.
5. *Dry sulphur removal* — The gas then passes through three parallel activated iron-oxide impregnated shavings towers for the removal of the organic sulphur burned in the cracking chamber. Three towers are used for each cracking chamber, a total of 12 towers for the plant. One of these towers is shown at the left in Figure 23.
6. *Cooling* — The gas is then passed through cooling coils, Figure 24, where it is cooled to the desired dew point.

For a complete technical description of the plant see H. L. Halstead's paper, "The Sparrows Point Central Station Prepared Atmosphere Gas Plant" presented before the Philadelphia Section, Association of Iron and Steel Engineers, on February 2, 1946, and which

Figure 18 — Instrument panel of cold-strip tin-mill annealing department.

paper will be published in the *Iron and Steel Engineer* in the near future.

Prepared furnace atmosphere for tin plate coils is far more critical than for black sheets and galvanized stock. Any atmosphere that will meet the tin plate specification will be all right for the others. The prepared gas that we propose to make is as follows:

CO_2 — 6.5 per cent
CO — 8.5 per cent
H_2 —11.0 per cent
N_2 —74.0 per cent
Dew point —60 F

Seven cu ft hr of atmosphere gas generating capacity is provided for each lineal foot of inner cover sand seal, based on the assumption that all covers are being loaded on all bases and operating at the same time.

A discussion of our prepared atmosphere gas in connection with the work it has to do follows:

1. *Brightness* — The gas is suitable for bright annealing because of the high hydrogen content. Our practice is to start the furnace on the charged inner covers and turn the atmosphere gas on when the steel reaches a temperature of 850 F. This saves time and effort in purging, and prevents explosions in the inner covers. The gas is then left on until the charge cools to 300 F and below.

2. *Carbon edges* — Carbon edges are basically caused by inadequate cleaning of the strip in the washers. The strip washing operation is dependent on rotating brushes, the edges of which are worn excessively by the weaving strip and this washing is therefore none too reliable. Palm oil, soap, etc. left on the edges of the strip are burned into the strip unless volatilized

Figure 19 — Bottom of tower used to remove sulphur from coke-oven gas.

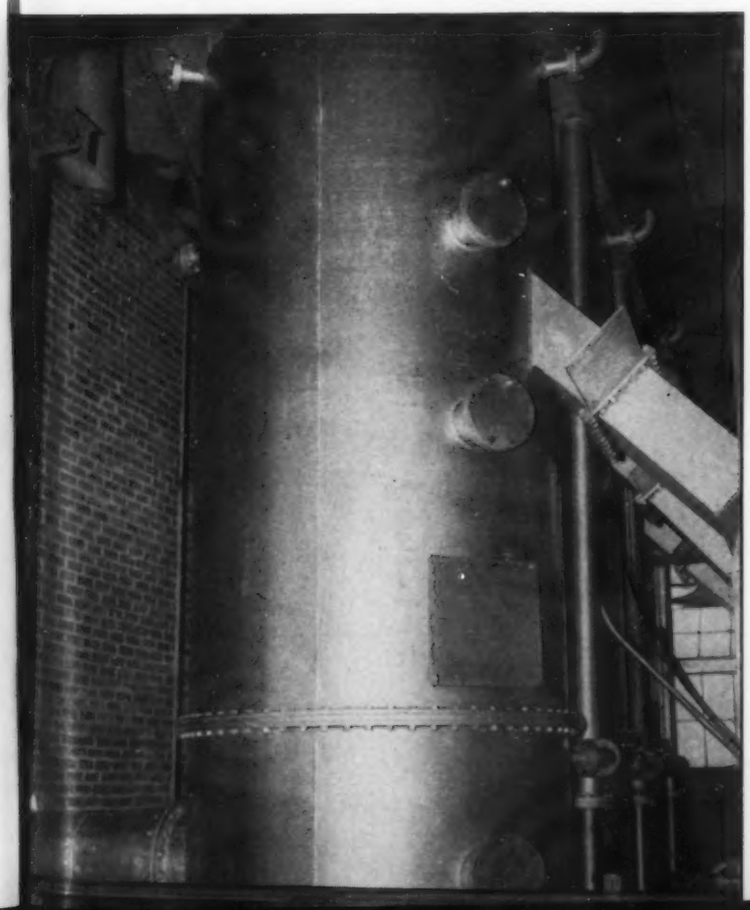
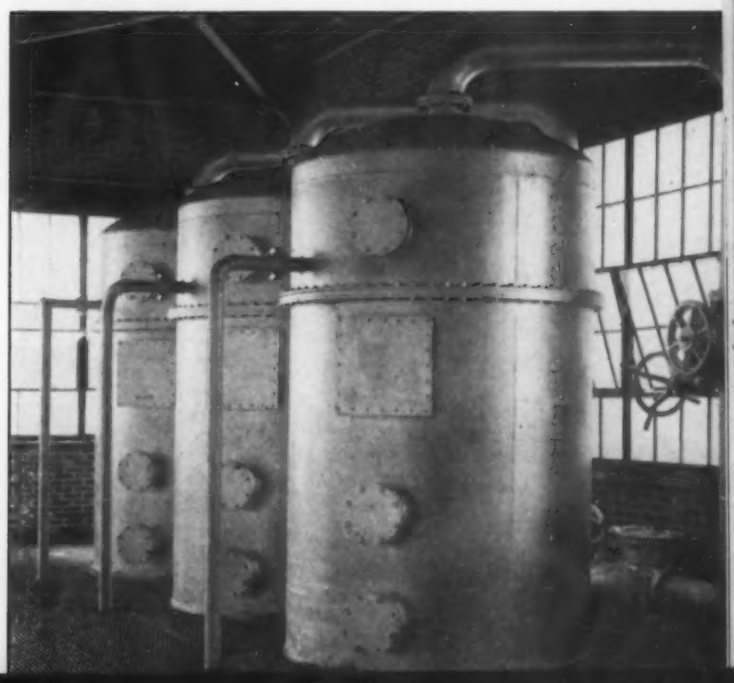


Figure 20 — Top of tower used to remove sulphur from coke-oven gas.



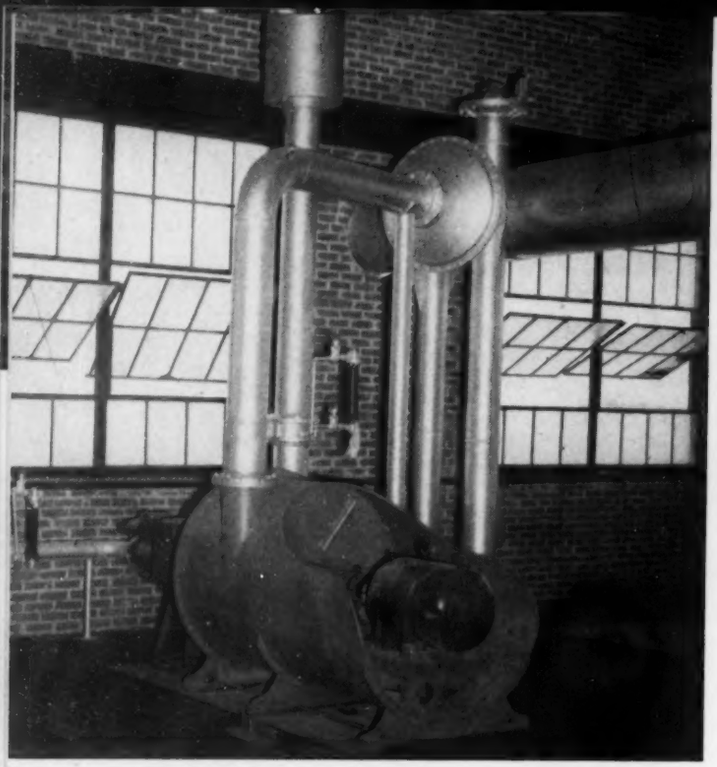
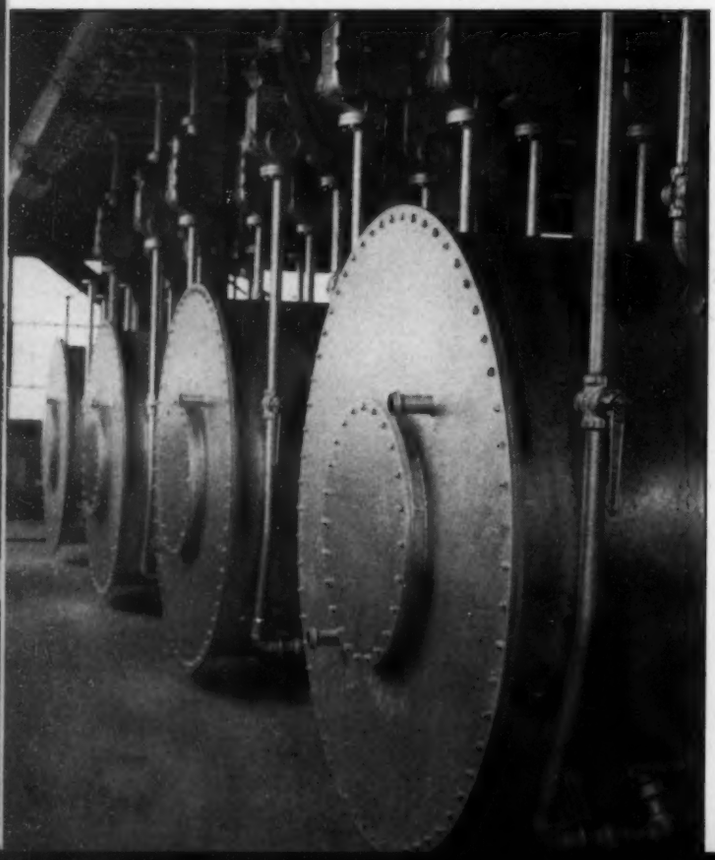


Figure 21 — Equipment for carburetion of central station atmosphere gas plant.

by the atmosphere gas. As the atmosphere gas will penetrate a tightly wrapped coil by more than two inches, it luckily takes care of most of this carbon edge difficulty. A high CO_2: CO ratio, together with a controlled dew point of 60 F and an annealing

Figure 22 — Cracking chambers for atmosphere gas.



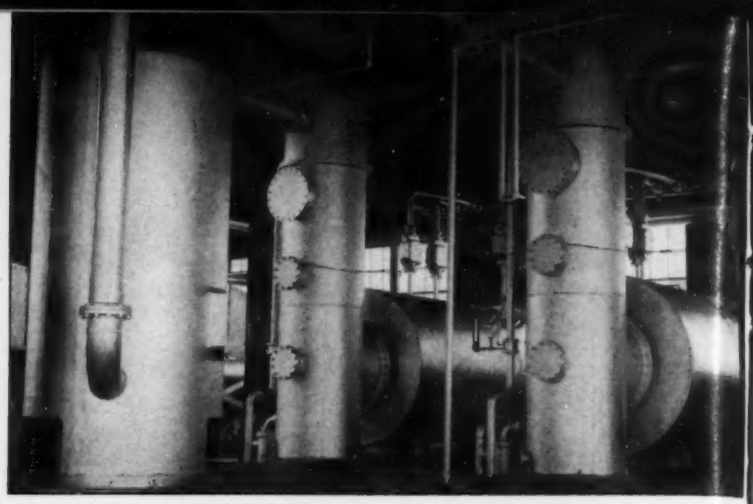


Figure 23 — The two vertical towers on the right are the beryl saddle cooling towers, and the horizontal chambers are the cracking chambers. On the left is shown a tower filled with iron-oxide impregnated shavings for removal of organic sulphur.

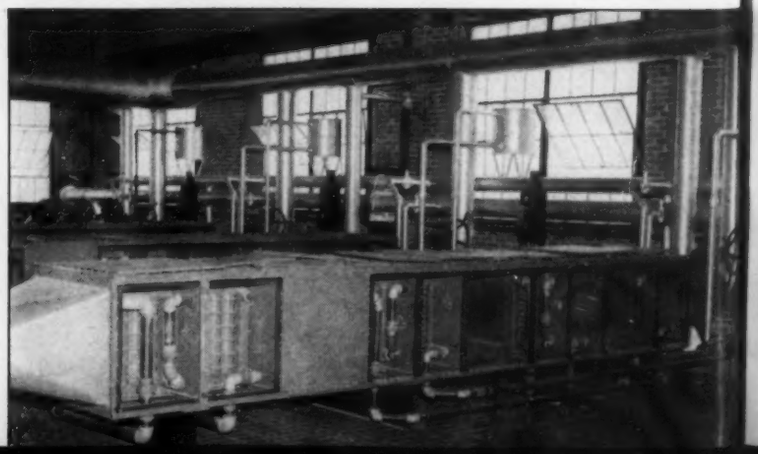
temperature of 1200 F or higher are designed to minimize carbon edges.

3. *Shadow edges* — This defect occurs throughout the width of the strip, usually as a scalloped border. The defect does not show on hot-dip tinned plate, but is apparent on light coatings of the electrolytic process. Flat cold rolling and tightly wound coils should help this problem.

   The cause of this condition has not been fully determined. Inasmuch as a furnace atmosphere can only penetrate the edges of a tightly wound coil to a depth of approximately two inches, control beyond this point by atmosphere gas appears to be impossible.

4. *Corrosion resistance* — It has been known for some time that the corrosion resistance properties of tin plate to certain acids such as prune juice, etc., vary across the width of a coil annealed strip. The corrosion resistance near the edges of the strip is less than that in the middle of the strip. This condition does not exist on continuous annealed strip where the time cycle of anneal is very short as compared to the coil-annealed process.
   The cause of this defect is not fully understood and is still being studied.

Figure 24 — The gas is cooled to the desired dew point in the cooling coils.



DISCUSSION

PRESENTED BY

W. D. LAMONT, Manager, East Plant, Dominion Foundries and Steel Company, Hamilton, Ontario, Canada

HAROLD V. FLAGG, Combustion Engineer, American Rolling Mill Company, Middletown, Ohio

W. HOWELL, Niles Rolling Mill Company, Niles, Ohio

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

O. W. MORRIS, Combustion Engineer, American Rolling Mill Company, Ashland, Kentucky

A. G. PIEMME, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

LEE WILSON, Lee Wilson Engineering Company, Cleveland, Ohio

R. V. CORDINGLEY, Tin Plate Metallurgist, Youngstown Sheet and Tube Company, East Chicago, Indiana

JOHN M. CROCKETT, Assistant Metallurgical Engineer, Technical Sales Division, Air Reduction Sales Company, New York, New York

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

W. D. Lamont: Referring to the chart that showed the time cycle, the greatest gain seemed to be the decrease in cooling time. That, I take it, can hardly be credited to the direct firing principle.

Harold V. Flagg: I have been very much interested in hearing Mr. Fisher's account of the new developments in sheet annealing at Sparrows Point. They have accomplished some very interesting things, particularly from the standpoint of protective atmospheres. The description of the plant and the accompanying photographs indicate that they have engineered an atmosphere generating plant which is much more extensive and complete than those ordinarily found in cold strip mills. It is evident that the importance of atmosphere gas composition and supply has been given due recognition in this installation.

The developments in furnaces are interesting. I was particularly interested in the center eductors made use of in the double furnace. This appears like a very simple solution of the problem of how to get heat to the center of the double charge without installing center burners.

The discussion of inner cover maintenance was interesting. The coatings developed to increase cover life are very interesting and should prove to be well worthwhile.

W. Howell: The speaker mentioned several times that the protective atmosphere had a dew point of 60. Does he not mean a dew point of minus 60? Otherwise what happens to the reaction inside the cover when the temperature moves down?

W. Trinks: I would like to know why Mr. Fisher has two different kinds of protective covers, one kind at the top and a different one at the bottom.

O. W. Morris: Was there any difference in the Btu requirements after protective coatings were applied to the inner covers? Have you had any trouble with the gas cracking and clogging up the luminosity pipe of your burners?

A. G. Piemme: In Mr. Fisher's analysis, he showed that with 11½-inch fans he was running 3.4 tons per hour and with 18-inch fans he was running 4.5 tons per hour. In a set-up where your fan size is limited to 15 inches and your speed is limited to 1400 to 1500 rpm what, in his opinion, is the maximum rate of production obtainable?

Lee Wilson: I would like to ask Mr. Fisher to clarify his suggested cost as to maintenance of radiant tube furnaces. He said they varied from 10 to 22½ cents per ton of product and by implication implied this was tube replacement cost.

R. V. Cordingley: I would like to ask Mr. Fisher if he has found in his work on corrosion resistance, whether annealing temperatures slightly in excess of 1200 F are better than temperatures up to 1200 F?

John M. Crockett: I would like to supplement the discussion on protective atmospheres, particularly in regard to the use of high nitrogen base gas.

At the present time tests are being made on a commercial scale to determine the effect of a protective atmosphere containing one to two per cent hydrogen, balance, nitrogen. It now appears that the small amount of hydrogen is sufficient to give a bright anneal, and that carbon monoxide is not necessary to prevent staining or blueing of the plate This gas has a dew point of minus 45 F.

W. Howell: On the protective covering for the covers, using sodium silicate with aluminum base, is it not found that the sodium silicate breaks up and crazes like enamel?

A. J. Fisher: Mr. Lamont has asked a question about the gain in cooling time of heat, which cannot be attributed directly to the method of firing. The table I showed more or less bore out the fact that the 18-inch fans, with the same method of heating, gave a much shorter annealing cycle, both as to annealing and as to cooling.

Mr. Powell asked about plus 60 or minus 60 degree dew point. That dew point temperature is plus 60 degrees, and it is plus 60 to eliminate carbon edges. If it were less than that, we feel we would have considerable difficulty with carbon edges, and that means additional scrap and less yield, a direct loss.

Professor Trinks asked about dual process inner cover treatment. We have a combination of treatment No. 1, which is the aluminum process, and treatment No. 2, which is the nickel chrome process. The nickel chrome process is considerably more expensive than the aluminum process, and therefore we decided that certain areas of the cover in which the conditions due to oxidation were not excessive, should be treated with the cheaper coating than the areas which required greater protection. The nickel chrome treatment costs about four or five times as much as the aluminum treatment, and so far we have not had sufficient time to run any of the treatment No. 2 nickel chrome covers to

destruction. We have had over 100 heats on them and they still look perfect.

Mr. Morris asked about the fuel rates of various protective coatings. There is no apparent difference in fuel rate in a protective coating cover than on one that does not have a protective coating. Some of these covers are white due to the silicate of soda coating, and others are black due to no coating at all. We have run several kinds of inner covers, in one heat, with thermocouples in each of them, and have found no apparent difference. We use coke oven gas and have had no trouble in clogging up the luminous burner pipes.

In answer to Mr. Piemme's question, we would expect about 4.0 tons per hour using 15-inch fans at 1400 to 1500 rpm. This tonnage could be increased by the use of coil spacers, corrugated inner covers, and greater fuel input if desired.

Mr. Wilson asked about the cover annealing cost. That in our experience is in terms of over-all costs of the cover, maintenance from all sources, radiant tubes, and everything else. It varies with the life of cover Of course, with new radiant tube furnaces, the maintenance cost is zero, which gradually builds up to a point where it averages in excess of 10 cents a ton as in our case.

Mr. Cordingley asked about corrosion resistance atmospheres operating in excess of 1200 F, indicating that improvement has been achieved by using temperatures over that figure. In answer to your question, I cannot give you any experience as to whether or not higher temperatures are better.

Mr. Howell asked about protective coatings for covers, in respect to sodium silicate covering on the treatment No. 1, which was aluminum. The sodium silicate is put on the cover to protect the aluminum from oxidizing to the atmosphere during the heat treating cycle of 1600 F for ten minutes. That gives the aluminum and steel time enough to react before the aluminum is lost by atmospheric oxidation. It is merely a transition covering. It does crack and peel off, and it serves no purpose in the final use of the inner cover.

HARDNESS GAUGE MEASURES MICROSCOPIC GRAINS WITHIN STEEL

▲ THE hardness, not only of a piece of steel, but of microscopic grains within the steel, can be measured by a new device designed at the research laboratory of United States Steel Corporation of Delaware. Still more minutely, the new microhardness tester can gage the hardness of a single steel grain at as many as three points within the breadth of a human hair.

Microhardness tester aids in the development of steels of definite hardness and toughness for specific applications in the home and factory, or railroads, ships and planes, and in the American family's automobile. The tester comprises a penetrating unit (left) and a mechanical stage (right) equipped with a microscope capable of magnifying the steel test field 500 to 1500 times. Hardness is measured by the diagonals of a diamond-made penetration in terms of microns, each roughly equaling forty millionths of an inch.

By no means an instrument of abstract research alone, this tester is in continuous use at the Kearny, New Jersey laboratory, perfecting studies of the microscopic constituents of steel. The results of these studies are coordinated to develop steels of definite hardness and toughness for specific applications in the home and factory, on railroads, ships and planes, and in the American family's automobile.

Like the Brinell, Rockwell, Vickers and other traditional hardness testers, but on a much finer scale, the Kearny device operates by indenting the polished surface of a steel sample. Its diamond-point penetrator under a load of a very few grams leaves a square mark which can rarely be seen by the naked eye. The diagonals of this tiny square indentation are measured in microns, or thousandths of a millimeter, and this reading related to the load placed on the penetrator so that hardness may be computed.

Preparation of the sample of steel whose hardness is to be measured requires elaborate care. A small sample, which may be mounted in plastic, is ground and finished with polishing paper, care being exercised so the grinding effect does not extend below the surface. Then it is polished on wet lead laps.

The microhardness tester measures with amazing accuracy the hardness of the hardest steel constituents. This is necessary to know the degree of hardness of steel grains themselves, and of the iron and other alloy carbides. The mechanism consists of the indenter with a square-base, 136-degree diamond pyramid penetrator, the mechanical stage for holding the specimen, a microscope capable of magnifying the test field 500 to 1500 times, and a control box. All parts are assembled on a heavy cast-iron plate supported by steel legs which rest on insulated wooden blocks to minimize effects of vibrations present in the building.

ELECTRICAL FEATURES OF A MODERN HOT METAL MIXER INSTALLATION

By W. A. MOSTELLER
Application Engineer
General Electric Company
Detroit, Michigan

and

L. R. MILBURN
Electrical Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

. . . . a recent hot metal mixer installation has found refined control justified for easy and close adjustment of pouring, and in reliability of operation . . . .

▲ WHENEVER there is a new installation using electric equipment there is a challenge to do a better job with the new tools acquired by industry. This was the case when the new hot metal mixer was installed at the Great Lakes Steel Corporation plant in Ecorse, Michigan. This paper describes the important electrical features of this installation with particular emphasis on the electrical systems used, that is, the power distribution system and the type of motor control.

HOT METAL MIXER

A hot metal mixer is a storage vessel which is charged with molten iron from the blast furnaces and which delivers molten iron after mixing, for charging the open hearth furnaces. Thus, it is seen that the mixer functions as a storage reservoir and also serves as a means of mixing the products of several blast furnaces to insure that the metal delivered to the open hearths is of a uniform analysis.

This particular mixer at the Ecorse plant is an extremely large one, approximately 28 ft in outside diameter and 36 ft long, lined with fire brick and capable of holding a charge of about 3,000,000 pounds of molten cast iron. In order to permit tilting through an angle of about 55 degrees for pouring, the mixer is mounted on rollers. Gas burners are provided which may be used, if necessary, to keep the metal in a molten condition. Also a motor operated door for charging and a very elaborate drive for tilting, which is the principal subject of this paper, is provided.

The mixer is charged with molten metal which is brought from the blast furnaces of the Great Lakes Steel plant located about two miles away. This molten metal is transported in so-called hot metal cars, which are moved on tracks between the blast furnaces and the site of the hot metal mixer. The molten metal from the hot metal cars is first poured into a ladle which is then lifted by a ladle crane for charging through a round door into the top of the mixer, shown in Figure 1. The mixer is discharged by tilting and pouring the metal into a ladle car which carries the metal to nearby open hearth furnaces. As a matter of further interest, the first mentioned metal cars come to site at ground level, whereas the second cars run on an elevated track which is at the approximate level of the open hearth furnaces.

One can readily imagine, due to the nature of the application (handling large amounts of molten metal) that is is very important to provide adequate safety measures. Referring to Figure 2 which shows a schematic arrangement of the mixer and associated tilting drive, it will be noted that there has been provided two duplicate driving motors each of which has adequate capacity for tilting and returning the mixer. Normally the two drives are clutched together and operate as a

Figure 1 — This hot metal mixer has a capacity of 1300 gross tons.

Presented before AISE Detroit District Section Meeting, February 19, 1946.

unit; but in case of failure of any part of one drive, the clutch may be disengaged and the other drive may then take over the operation of the mixer. There is also an additional safety feature, an air motor, which is connected to one drive so that in case of a total electrical failure during the pouring operation, the mixer can be restored to a safe position. Furthermore, interlocking of the several controls is such that the mixer cannot be tilted by means of the electric motors unless the air reservoir is at a safe operating pressure. In case of a power failure, the air operated equipment assumes control of the mixer and operates to return the mixer to a raised position. A "dead man" master switch is provided which must be held in the running position manually in order to operate the electrical equipment. If by chance the operator should release this switch momentarily, the electrical apparatus will return the mixer automatically to the normal position and stop the drive regardless of the position of the master switch. As an additional precaution against normal over-travel, which is protected by the usual track type limit switches, there are two "back-up" limit switches in the motor armature circuit. These limit switches, which are of the "Youngstown type", see Figure 3, open the motor armature circuit in case of overtravel in either direction.

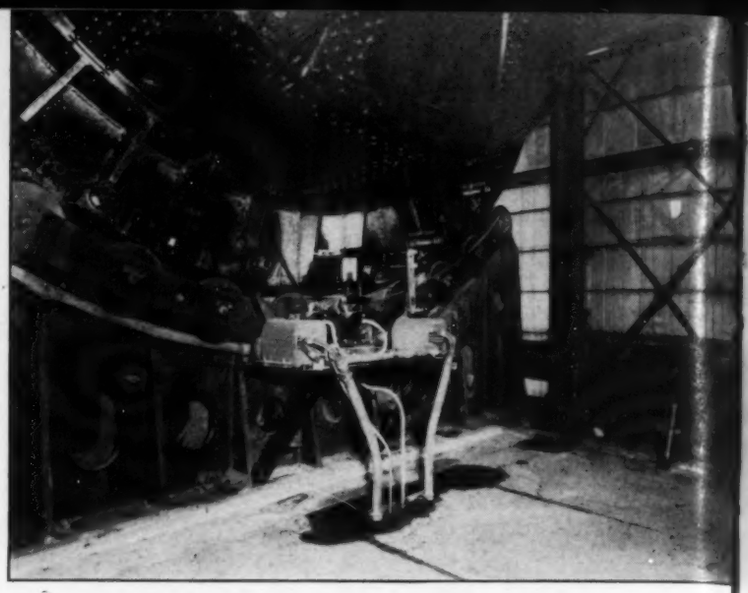


Figure 3 — The hot metal mixer is protected with normal and back-up overtravel limit switches.

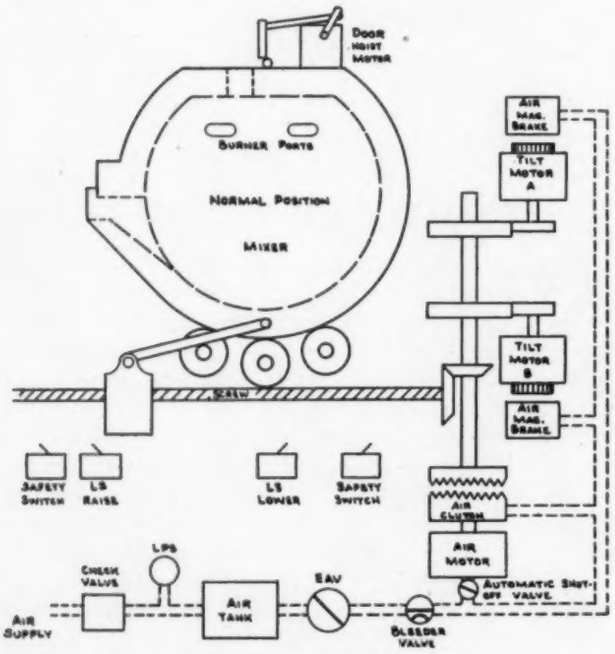


Figure 2 — Schematic diagram showing operation of hot metal mixer.

TILTING DRIVE ELECTRICAL EQUIPMENT

The operating duty on a hot metal mixer is not very severe. The average operation at this plant requires that the mixer pour once every 30 to 60 minutes. However, during the pouring operation, it is highly desirable to provide the operator with a control that permits accurate adjusting of the rate of pouring. Also it is well to have a control that provides uniform acceleration and deceleration. The electrical control system provided meets all these requirements.

Previously hot metal mixer installations employed conventional magnetic control, operating from the mill's 250 volt d-c constant potential distribution system. Usually two 180 hp, 420 rpm, 30 minute rated, 230 volt, series wound, mill type motors were used on this size of mixer for the tilting drive.

For this new installation, taking advantage of the modern tools that are now available, an adjustable voltage system employing amplidyne control was used. Figure 4 shows the motor-generator set and control components of the adjustable voltage system. This equipment receives power from the mill a-c system instead of the above mentioned d-c system.

The advantage of the a-c distribution system is one of economy, see Figure 5. Taking into account the cost of the conversion and distribution equipment, it is cheaper to deliver one kw to the mixer site by means of the plant's a-c system than d-c system. This practice is in line with modern practice in industrial plants where it is found to be far more economical to distribute power at high voltage to the point of utilization than to distribute power to the same point by a low voltage. This

Figure 4 — 65 hp, 30 minute rating, mill type shunt motors are used on the tilting motion of the mixer.

economic advantage brought about by use of a modern distribution principle plus economies realized in the adjustable voltage system of power supply to the mixer motors, made this installation a sound one from an economic consideration.

The adjustable voltage system makes use of two 65 hp, 535 rpm, 30 minute rated, 230 volt shunt wound motors for driving the tilting mechanism. The ability of mill type motors to operate at normal torque at voltages and speeds twice normal made this possible. However, it was necessary to make a change in the reduction gear ratios to compensate for the increased motor speed at the double voltage. The motors have their shunt fields arranged to permit field forcing. Field forcing will enable the motors to develop maximum torques equivalent to the previously used series motors.

Power for these motors is supplied from a motor-generator set consisting of two d-c generators and a squirrel cage induction motor. In order to increase the interchangeability of the equipment, the two generators were made duplicates of the tilting motors but operated at 1200 rpm, thus making them capable of providing the 200 per cent voltage which was required for the motors. The generator fields were designed for approximately twice the excitation voltage of the motor fields. The fields of the motors were connected in series-parallel and the generator fields in series.

The induction motor of the motor-generator set was rated 150 hp, 1200 rpm, 40 C continuous, 440 volt, 3 phase, 60 cycle, with a maximum torque capacity of 250 per cent. The motor will be ample for driving the generators at their combined rating of 120 kw for 30 minutes.

Also, there was supplied an auxiliary motor-generator set consisting of a general purpose exciter for general excitation and control of power, and two amplidyne generators, one for each main generator field. This set is also driven by a squirrel cage motor. These amplidyne generators, which provide the important control functions, will be described more in detail.

The amplidyne generator has the appearance of a conventional d-c generator. However, its characteristics are quite different and depend upon its unique design, shown in Figure 6. This figure shows diagramatically an amplidyne fully loaded and will be useful in understanding its characteristics and operation. These characteristics are obtained by short circuiting the normal brushes of the machine and placing the load brushes at 90 degrees from the short circuited brushes.

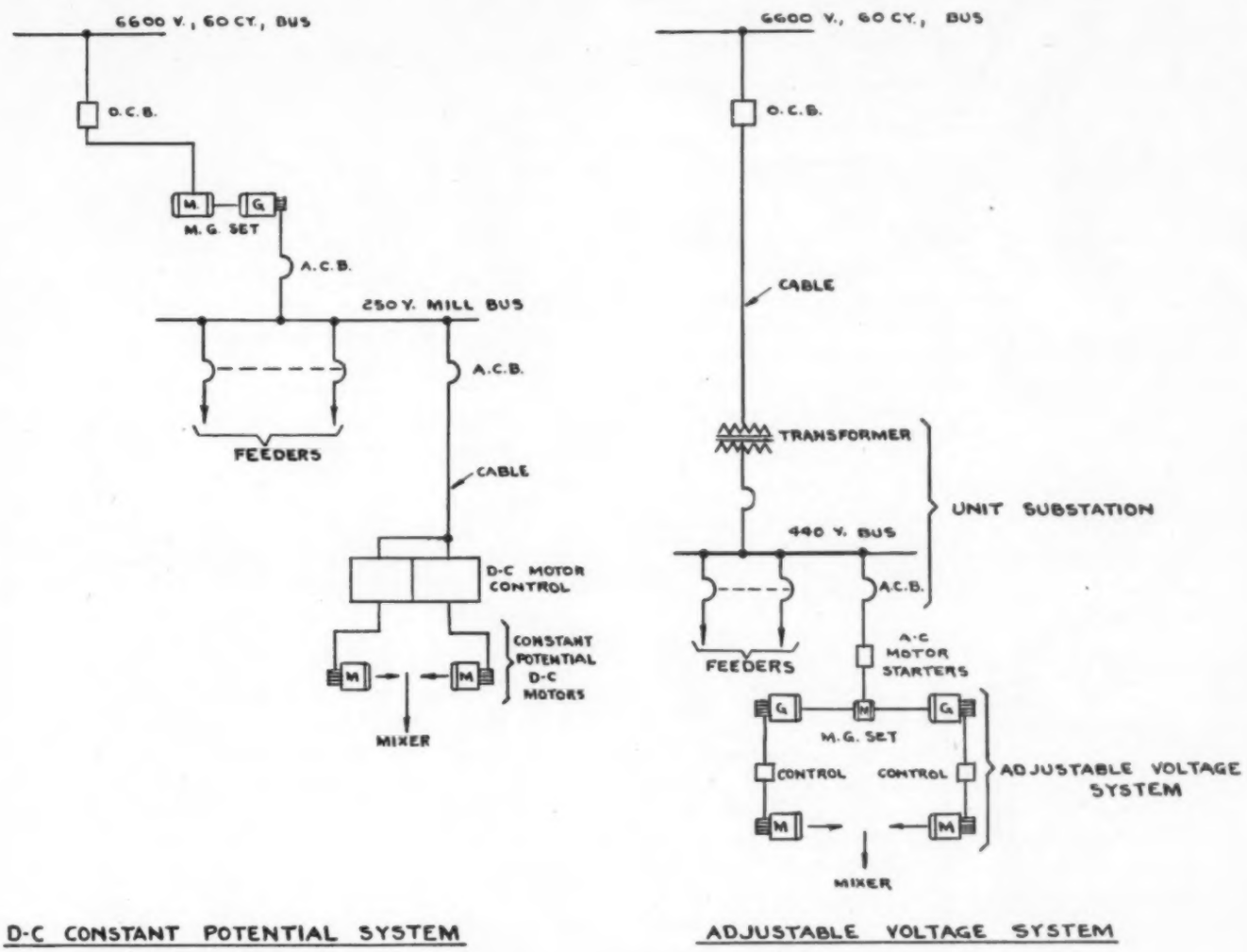


Figure 5 — The mixer takes its power from the a-c distribution system.

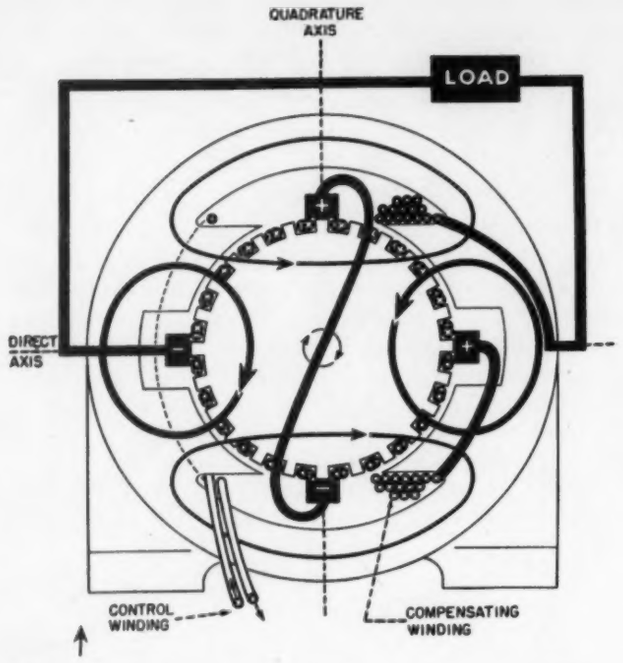


Figure 6 — Diagrammatic sketch showing amplidyne, fully loaded.

There is also a field wound on the main field structure and in series with the load which compensates for the load flux. With a machine arranged in this manner, a small flux from a control field produces a voltage which circulates current through the short circuited armature. This short circuit current in turn produces a flux which produces voltage across the output brushes. When the load current is flowing, the series field provides the necessary compensation for the load flux thereby allowing the main field to produce the output voltage. The combined result is a machine of high response and high amplification. Almost negligible amount of excitation power is required to provide control over a sizable amount of power delivered at the output brushes.

These inherent characteristics of the amplidyne provide advantages in the control of the mixer. These advantages are current limit or torque control of acceleration and deceleration which permits the maximum rate without exceeding commutating capacity of the rotating equipment; good voltage maintenance for any given operating speed; elimination of moving contacts in the voltage and current control systems; simplification and reduction in number of control devices thereby reducing maintenance; and finally control adjustments can be made easily, and when once made are permanent.

By reference to Figure 7, it is seen how the amplidyne

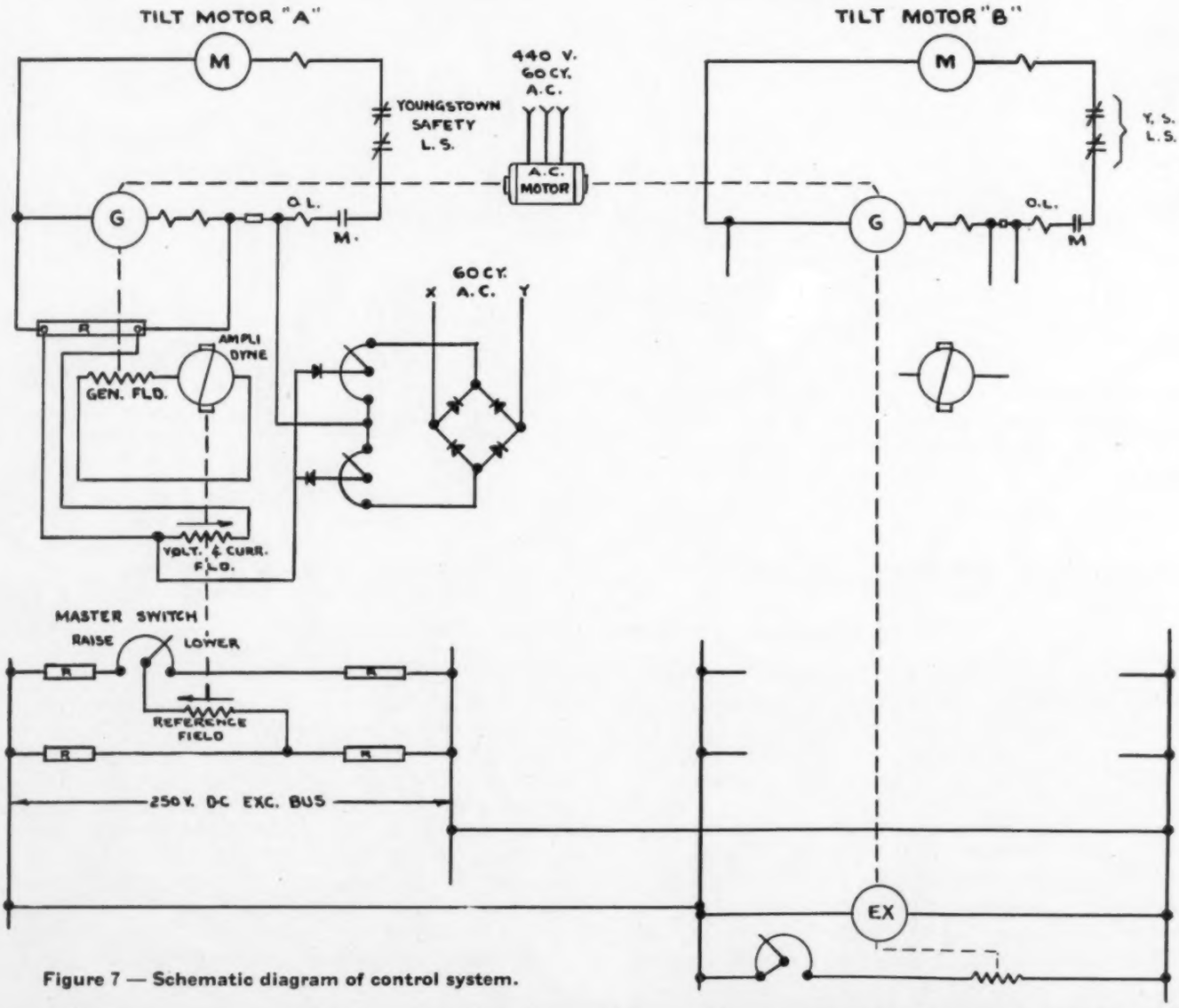


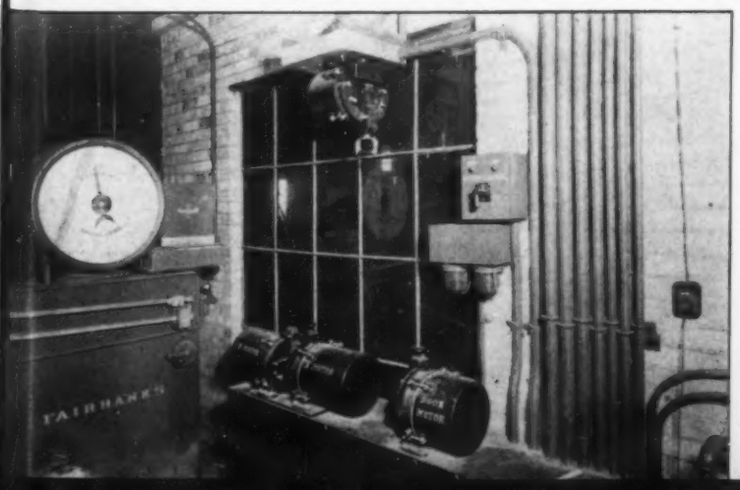
Figure 7 — Schematic diagram of control system.

is incorporated in the control system of the mixer tilting motors. Each motor is supplied from its own generator. The amplidyne generators are used to supply power to the generator fields. Two control fields are used on the amplidyne. One field is called the reference field, where the desired signal "raise" or "lower" is set up by the master switch. The other field (voltage and current) opposes this reference field. When the net flux, as developed by these two fields, is such that the generator voltage is of the proper magnitude and the motors run at the proper speed as determined by the master switch, the system operates in equilibrium. Any change in the master switch upsets the equilibrium and a new voltage and speed is brought about. In order to control maximum torque of an adjustable value in either direction, a current limiting feature is provided. This consists of suitable resistors and blocking rectifiers which are connected across a resistor in the generator-motor circuit and in series with the voltage control field. If the current in the motor circuit exceeds a predetermined value in either direction, a signal is set up to change the generator voltage in the appropriate direction to limit the current to the predetermined value. This action prevents unusually large currents in the electrical system which would upset machine commutation and produce large torques in the mechanical system which might severely strain the mechanical parts.

The control is designed as two independent drives each having duplicate features and functions. The mixer will be controlled by the combination of two speed control master switches located in the operating pulpit, shown in Figure 8. The switches are connected together for unit drive. These master switches provide a large number of speed points in either direction. Furthermore, in case of trouble with the electrical equipment of one motor, the master switches can be divided and only one used for the drive in working condition.

Each drive is equipped with an air magnetic brake with low voltage shunt coil arranged for forcing for rapid releasing. The brake circuits are arranged so that both brakes are energized when either motor is operated. This feature permits the drive to continue to operate in case one motor fails without the necessity of manipulating any control devices. As previously mentioned, a "dead-man" master switch of the gravity reset type is used. The purpose of this switch has already been given.

Figure 8 — The control pulpit of the 1300 gross ton hot metal mixer is equipped with an overhead gravity-return "dead-man" master switch.



The control system also provides against overvoltage, loss of control power, overload, and loss of motor field. As shown by Figure 4, the control is of open construction and mounted on angle iron supports. Necessary instruments and control devices are provided. One common exciter is used for both systems.

CONCLUSION

Undoubtedly, the above described installation possesses many more refinements than heretofore thought necessary for a mixer installation. However, the desire to have an easy and close adjustment of the pouring rate makes a refined control necessary. The justification of this requirement and the reliability of equipment used has been proved by more than one year of successful operation.

DISCUSSION

PRESENTED BY

A. W. MOHRMAN, Electrical Superintendent, Michigan Steel Division, Great Lakes Steel Corporation, Dearborn, Michigan

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

C. E. S. EDDIE, Assistant Superintendent, Steam and Fuel, Great Lakes Steel Corporation, Ecorse, Michigan

J. A. SHIMMIN, Superintendent of Maintenance, Rotary Electric Steel Company, Detroit, Michigan

W. A. MOSTELLER, Application Engineer, General Electric Company, Detroit, Michigan

A. W. Mohrman: I see, that there are two sets of motors and an air motor; are you afraid of your motors?

L. R. Milburn: The manufacturer of the equipment had no experience with adjustable voltage controls. They have had a circuit breaker trip when they were pouring and there was trouble, and this is why we put on an air motor and for the same reason as we have the back-up limit switch. If we go through the control limit switch, we go into the Youngstown limit stops, which stops us definitely. We cannot overturn the mixer. Now, if the power fails, you have no control over your mixer if you want to return it back to a safe position. The air motor, if there is enough air in the line, will bring it back to a permanent perpendicular position.

A. W. Mohrman: Is the air motor engaged at the time?

L. R. Milburn: No.

A. W. Mohrman: How much time is there between the time the electric motor stops and the air motor goes into operation after the electric power fails?

L. R. Milburn: The air motor is not engaged; it automatically comes on when power fails, and I believe that it is tested once a week, or oftener. It depends on

the operator, when he wishes to see if he has his air motor on.

C. E. S. Eddie: I might add that the control is so designed that you cannot operate the control unless the air pressure is up to working pressure, or ready to go; so, if the pressure is low, you couldn't operate the electric motors until the air pressure is up. I might add that you have a storage tank on the air compressor system in the event of failure of the motor driving the air compressor, and there is enough air stored up in the system to move the mixer back into the normal position.

L. R. Milburn: It is also connected to the plant air system.

J. A. Shimmin: If you have an air motor control on the hot metal mixer and one d-c system can handle it, is there any economic justification for having two d-c systems without also having a duplicate a-c system?

L. R. Milburn: The air motor will only return the mixer to the one position, the up position. We have to depend upon electricity to tilt and pour the metal into the ladle that is going into the open hearth.

Now, years ago, as I understood, they started out with one motor and had trouble. So, they put on two motors and depended on the d-c system. When we bought our mixer we had two motors planned of one hundred horsepower each, so it would be big enough in case one failed. If the breaker kicked out on one of the motors, it would still tilt on the other motor. Now, our thought was that amplidynes are coming along, let's try one of them, if it does not cost any more. They turned out to be reasonable in cost providing that we would cut the horsepower requirement. By being able to force and apply twice normal voltage to the motors, we were able to cut the motors from 100 hp to 65 hp, and in that way we accomplished the same thing as having duplicate motors. Then we went one step farther and made the generator duplicates of the motors, and we carried one unit as a spare for generators or motors. The only difference between the motors and generators is that when they are running as generators we put fans on them or opened the hole so that the air can be circulated, and when used as motors we plugged the holes and connected them in the series fields.

C. E. S. Eddie: To supplement part of the question asked, Mr. Mosteller mentioned that on this hot metal mixer there are two burners. These burners are "Bloom" type, three hundred and seventy-five E. T. gas burners, The heat insulation and efficiency of this unit are very good and we found that the amount of gas necessary to keep the iron at temperature is negligible. In fact, sometimes the burners are shut off entirely over quite a long period of time, if the shop is taking iron consistently, which indicates that the unit from a heat conservation point of view is well designed.

L. R. Milburn: Another feature we wanted in this control was that of uniformity of pouring. With a rheostatic type of control, you get jerky tilting. You want to pour slow and yet you want to keep moving all the time. With amplidyne control and adjustable voltage we can get any degree of tilting that we want and any speed from practically nothing up to the maximum speed of full voltage, and that gives a uniform stream of metal into the hot metal ladle.

Member: Do the control motors run all the time' or do they turn them on and off?

L. R. Milburn: That depends upon the operator; he can continue to pour or he can regulate as he sees fit. I have seen some of the operators start it and keep adding to it as they go along and others kind of keep checking as they go along. But if he watches his voltage and does not control too much with the master switch he can start the tilting and keep on pouring. He also has to watch his scale too because he weighs the metal as it comes out of the hot metal mixer.

C. E. S. Eddie: Have you run into any problems on the handling of the ladle from the bottom pit up into the mixer itself?

L. R. Milburn: No. We had a little trouble at the start in that the operator could not accustom himself to positioning the spout of his ladle over the charging opening in the top of the mixer, and, of course, he spilled much of the iron. He would also pour too fast.

C. E. S. Eddie: Did you suggest any method, or did you set up some schedule for him to follow on the travel?

L. R. Milburn: No. He worked it out himself. He found out that by pouring at a certain rate and having his ladle in a certain position he could hit the opening in the vessel without splattering the metal all over the place.

W. A. Mosteller: I think that Mr. Shimmin had a pretty good point there, and I want to say that that point was gone into during the negotiations. We did consider two motor-generator sets and one motor-generator set with two generators, but the way we reasoned was to analyze which type of equipment might cause the most trouble. We thought the a-c would cause the least trouble because we knew the squirrel cage motor was a simple piece of equipment; therefore, we thought it was safe enough to provide just one motor with one source of power. I believe that the plant has a similar important installation on the skip hoist drive at the blast furnace where one a-c motor is driving two generators in which they have proven that the a-c motor doesn't give very much trouble. It is on that basis that we figured we could resort to this same kind of motor-generator set arrangement here.

I would say that the amplidyne in the usual case is supplied to a job that has the opposite requirements from this job. Usually you want an amplidyne to be on a drive where you want fast operation, such as fast acceleration, and fast retardation. In this case we used an amplidyne because it is possible by use of a very small type of control, a master switch, to get a very fine uniform degree of pouring, but ordinarily amplidynes are used if you want fast operation.

L. R. Milburn: Even with two motor generator sets we could get into trouble, because you would have to have an automatic throw-over, to have both sets running to be sure of a pour. Even with the automatic throw-over, there is a time when you are going to lose your power. So, I think that the one motor generator set, and one driving motor, is just as reliable as two motor-generator sets, unless of course you burn up the motor and then you are down until you can install your spare.

The Heating and Rolling of Strip Steel

. . . . recounting some principles of operation of the modern continuous wide strip mill . . . .

By PAUL CARNAHAN, Assistant General Superintendent
Great Lakes Steel Corporation
Ecorse, Michigan

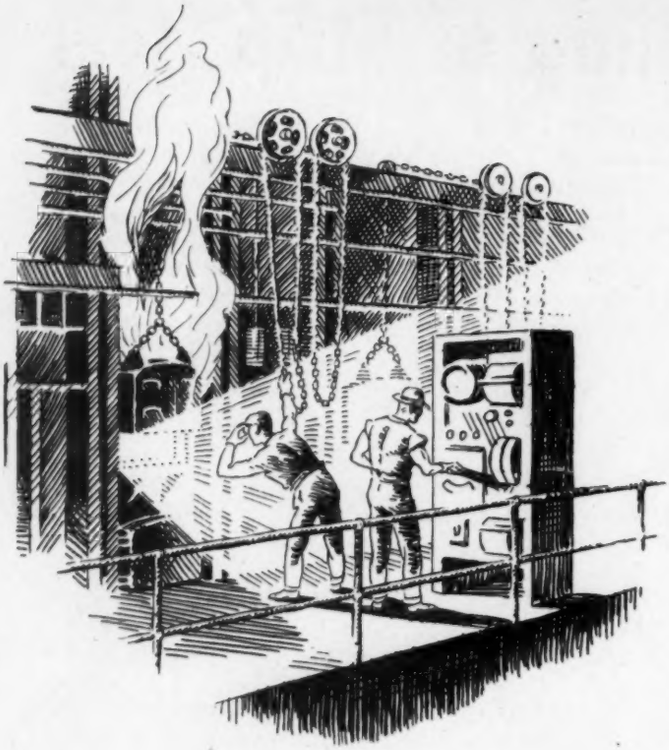
Presented before the AISE, Detroit District Section Meeting, April 9, 1946

▲ GENERALLY speaking, strip steel is that material between 0.025 and 0.250 in. gauge and below 12 in. in width. Commercial sheets are those sizes wider than 12 in. and in the same gauge limits up to 48 in. in width, and from that width on, the top gauge limit for sheets is 0.187 in. This last mentioned classification of sheets is where the bulk of the tonnage is ordered today on the modern strip mill so that this type of mill would probably have better been called a continuous sheet mill.

It might be interesting to try and give a brief outline of the development of the modern mill which has so radically changed the manufacture of sheets and strip in the relatively short space of twenty years. As stated in "The Modern Strip Mill" published by the Association of Iron and Steel Engineers; the American Rolling Mill Company in 1923 built a mill invented by John B. Tytus, culminating ten years of experimentation. This mill, located at the company's Ashland plant, was based on sheet practice, and its development required accurate determination of many technical phases of the rolling process, as well as the discard of many previously accepted theories and ideas. It was found that successful continuous rolling depended on the shape or contour of the mill rolls, the temperature of the rolls, the deflection occurring in the rolls, roll spacing or screw adjustment, and the shape composition and temperature of the piece to be rolled. This mill differed from today's version of the continuous strip mill in that there was a reheating furnace located in between the roughing mill and the finishing mills so that the material was reheated during the operation rather than being rolled from a single heat as is common today. However, this mill demonstrated the commercial practicability of hot rolling wide, thin, flat material in multiple lengths by the continuous process, and is still in operation, the only continuous sheet mill in the united States. In 1916, the possibility of producing strip continuously in sheet widths was conceived by A. J. Townsend and H. M. Naugle, who designed and built a mill at the National Pressed Steel Company, Massillon, Ohio, to roll strip of 6 to 24 in. of width down to 16 gauge or 0.062 in. and heavier. This was the first application of the universal mill to roughing for hot rolled strip. The experience gleaned from this mill proved to Townsend and Naugle the feasability and possibilities of further application of strip rolling practices to sheet widths. Accordingly, these men in 1926, first produced hot rolled strip in widths up to 36 in. on a mill of their own design and construction in the plant of the Columbia Steel Company at Butler, Pennsylvania. This mill became the prototype of the present day mill.

Thus we find the continuous rolling process for sheet material reached by two separate paths, the one mill using the intermediate heating process while the other rolled direct from the original heat. It is generally recognized that the two outstanding major developments in perfecting the continuous rolling process as it is today practiced, were the application of the four high mill and the Ward-Leonard control system. The four high mill with suitable bearings supplied the mill rigidity so necessary for the successful rolling of wider material to the lighter gauges within acceptable tolerance limits. The control system on the finishing train drives provided a flexibility of speed adjustment of these mills, which made possible the proper correlation of mill drafts in the successive stands. Following the developments of the two mills outlined above, each successive year saw new installations until 1941 when there were in this country 28 mills of this general type representing an investment of $450,000,000 and having an output of approximately 18,000,000 tons annually.

This development was destined to play a greater part in history than any of its pioneers dreamed. For when this country was plunged into war in 1941, it was recognized that one of the most needed of all materials was plate steel so necessary in the construction of the ships that were necessary to carry men and materials to far-away lands in order to defeat the enemy on his own grounds. It is to the everlasting credit of the men of the steel industry, that they immediately recognized that the only way that this material of war could be



quickly produced was by the use of existing facilities which were never designed for the job they were now called on to do. These mills, which were designed to produce materials for civilian needs, were now called upon to produce materials, which at the time of their design and installation would have been thought impossible. However, they did produce these materials in unlimited quantities and this accomplishment was one of the major factors contributing to the defeat of the enemy. With this review of the background of the modern strip mill, we shall now attempt in a limited way to give a picture of the operation of one of these modern units.

The mill that has been selected for our discussion is the 96 in. continuous, hot strip mill of the Great Lakes Steel Corporation. This mill is one of several large units in the steel industry that is capable of rolling materials to widths and gauge tolerances that a few short years ago would have been impossible. The aim of each operator of a continuous strip mill is, of course, to furnish a quality product that will meet the specifications of the customer so that it will give satisfactory service in the use for which it was intended. A brief definition of the word or term quality as used above, might be in order. By quality, we mean that our materials must be within the tolerances for gauge, width and length, have surface finishes that are above reproach, and possess physical qualities that will meet and surpass all the rigid requirements for which the steel is intended to be used.

All of the foregoing requirements are made and controlled to a great extent by the heating and rolling of the steel. To try and make this picture clear, we have for the sake of clarity divided this operation of heating and rolling into four distinct steps. In each of these steps we shall give a description of the operation of the unit together with a brief description of the equipment used in the unit. The four phases or steps are first, the providing of steel, second, the heating of the steel, third, the rolling of the steel, and fourth and last, the finishing or delivering of the steel subsequent to rolling.

1. *Providing of the steel* — In order to provide a high quality slab, from which all the materials of strip mill are produced, the greatest care must be exercised from the open hearth through the soaking pits and blooming mills and finally through the conditioning department where the final processing of the slab is performed, and following which, it is ready for charging into the reheating furnaces. In effect, each order received is custom made, inasmuch as the schedule department orders the correct analysis steel from the open hearth department and schedules the proper size moulds for pouring the steel so that the blooming mills will be able to make the slab size best suited for making the order. After the slabs are made on the blooming mill, the next step in the process is to condition the slab or to remove any defects on the surface that might carry through the heating and rolling and cause the strip or sheet to be rejected.

The conditioning for the strip mill is done mainly by the oxyacetylene scarfing or deseaming process. This is a development that has very nearly paralleled the continuous strip mill in progress. The large tonnages that the strip mill can produce in 24 hours made it necessary to find some method besides hand chipping, and the scarfing process is the answer. When the slabs finally leave the conditioning beds, all the scabs, slivers, seams and other surface defects have been removed, and the slabs are now ready for scheduling in their proper rolling sequence on the mill. Lining up the orders or scheduling the steel has a very important place in the heating and rolling of strip, for unless the slabs are placed in their proper rolling order, a great deal of production can be lost on the mill.

2. *The heating of the steel* — Keeping in mind the definition previously given for quality, we now come to a most important operation, namely the heating of the steel. For unless the slabs are uniformly heated to the proper rolling temperature, and have a scale jacket that will readily clean up in rolling, it will be almost impossible to obtain the quality factors desired. In addition, a poorly heated slab may cause trouble on the mill in rolling, resulting in mechanical difficulties which cause delays in production. Good rolling practice requires an evenly heated, well soaked slab at the usual temperatures of from 2150 to 2250 F.

Strip surface requirements further impose certain scale conditions which require careful furnace operation. The scale jacket should be even and brittle, but unbroken so that it may easily be removed by the scalebreakers and hydraulic sprays. This condition is generally attained by having the furnace atmosphere practically free of carbon monoxide or other unburned gases. The main heating zone may be set for perfect combustion while the soaking zone should incline to the excess air side having 3 to 5 per cent oxygen in the gas analysis.

The equipment of the installation we are describing, for the reheating of the slabs consists of three, triple zone, oil or gas fired furnaces. Each furnace is approximately 82 feet long by 18 feet wide. Each furnace has a rated capacity of 56 net tons per hour from cold to

2250 F, based on slabs of from 3 to 6 inches thick, by 36 to 60 inches in width, consisting of two rows 7 feet 6 inches long or one row 16 feet long. These furnaces are equipped with an automatic temperature control on the soaking zone, and with a fuel air ratio control on each firing zone. Fuel is introduced through six burners spaced across the furnace in the main heating zone above the steel, and six more burners below the steel in the same zone. In the soaking zone, there are six more burners spaced across the furnace and above the steel. All firing is counter-flow to the movement of the steel through the furnace. Each furnace is equipped with recuperators of the refractory tile type for preheating the air for combustion purposes.

The slabs move through the furnace on water cooled skid pipes extending from the charging door in the back, up to the point where the slab enters the soaking zone. The furnaces are of the end charge, discharge type which means that each time a slab is pushed in the back end of the furnace, one is discharged on the rolling side of the furnace. In connection with this, it might be well to mention that the furnaces are located at right angles to the mill. In back of the furnaces there is a set of table rolls across which the slab moves into charging position, and is then shoved into the furnace by means of a motor driven pusher or ram. The length of time that the slab is in the furnace depends on several factors which are mainly the rate of rolling on the mill, the width and thickness of the slabs to be heated, and the working conditions of the furnaces. The slabs are charged and drawn in rotation, in other words, starting with the first furnace then going to the second, the third, and repeating, each order of slabs being located by means of markers in the furnaces.

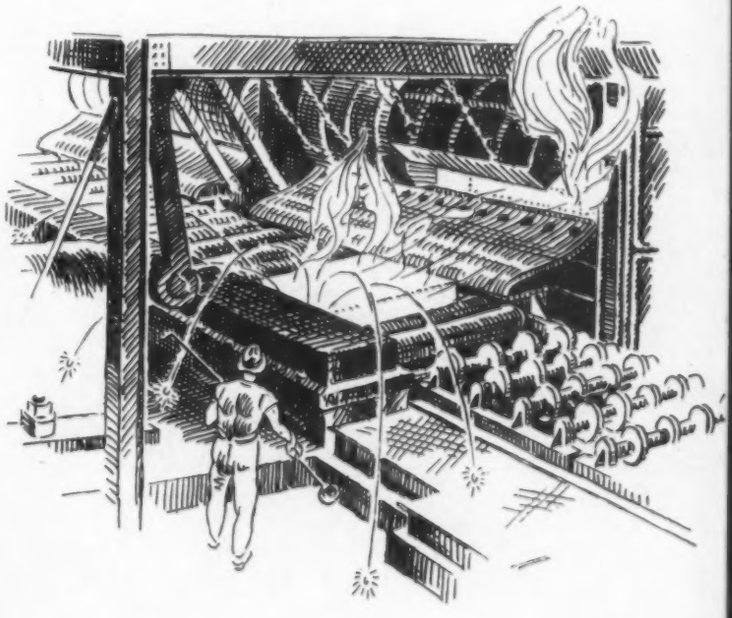
The furnaces are operated by a heater well versed in the requirements of his job, and fully aware of the very important part the heating of the slabs plays in having his mill turn out a quality product that will satisfy the strict requirements of the customer and result in repeat business which will in turn provide him with steady work. In summing up the part that the heating plays in the rolling of the strip, we may safely say, that unless this most important operation is done to as near perfection as possible, the resultant product will not measure up to the quality standards necessary.

3. *Rolling of the steel* — A brief description of the rolling mill equipment in its proper sequence may make the actual rolling operation more clear to the people who are not familiar with modern mills. The entire rolling train consists of the following rolling equipment: first is a two high scalebreaker followed by four roughing stands, each four high, then six finishing stands which are also four high. The auxiliary equipment located in the train consists of hydraulic sprays, slab squeezer, crop shears, and rotary flying shears. The scalebreaker is located immediately ahead of the No. 1 roughing stand. This is a two high stand driven by a 1000 hp, 300 rpm motor. The gear ratio is 6.36 giving a roll rpm of 47.1 which allows the slab to travel approximately 296 fpm. The distance from the scalebreaker to the No. 1 roughing stand is 31 ft 4 in.

Located between the scalebreaker and the first roughing mill is the first hydraulic spray. It might be well at this point to describe this descaling operation. Surface is, of course, one of the prime requirements of the hot rolled sheets and coils. One of the most important factors in securing this surface requirement is the effectiveness of the hydraulic descaling system. Unless all of the scale is completely removed from the heated slab, the desired results will not be obtained due to scale and other foreign matter being rolled into the surface of the finished product. Removing the scale is accomplished by means of a series of hydraulic sprays located at strategic positions through the mill train and mainly before entering the finishing train. Because of the difference in temperature, a cracking effect is set up loosening the scale which is then removed by the force of the water itself.

The No. 1 roughing mill is a four high, broadside stand, having work rolls 36 in. in diameter by 100 in. in length, backed up in the conventional manner by two back-up rolls 51 in. in diameter. This stand is driven by a 3000 hp motor having an rpm of 150. The gear ratio on this stand is 7.846 giving a roll rpm of 19.12 which allows the slab to pass through this mill at approximately 170 to 181 fpm. Immediately preceding this stand on the entering side and also on the delivery side is a turntable which allows the slab to be turned horizontally through 90 degrees. The lift is hydraulically operated, and the turning motion electrically driven. On spread rolling, both tables are used, on straight cross rolling only the one on the entering side, and on straight away rolling neither is used.

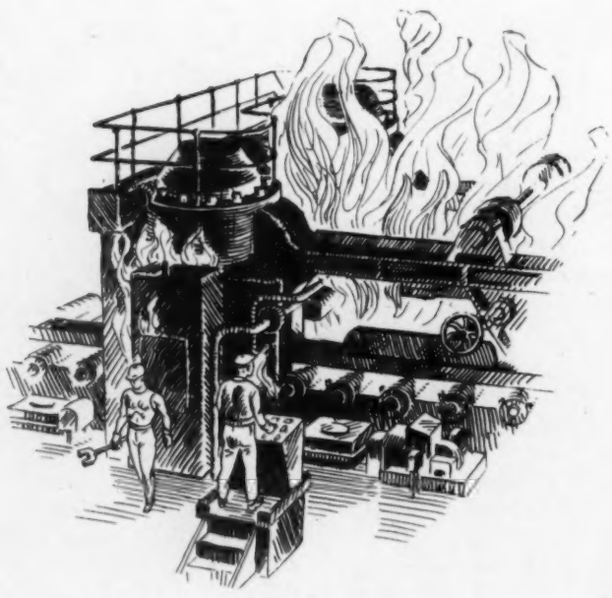
Also ahead of the No. 1 stand is a slab pusher, power driven, located on runways above the mill table. This is to insure having the short slabs enter the mill squarely, to avoid the long ears that occur when a slab enters this mill on a bias. Located between the first and second roughing stands is the slab squeezer used to square up the distortion of the slab that has occurred in No. 1 stand due to the heavy drafts. The distance from No. 1 to No. 2 stand is approximately 44 feet 5 inches. No. 2 roughing mill is four high, with work rolls 26½ in. in diameter by 96 in. long backed up by 51 in. back-up rolls. This stand is driven by a 3000 hp motor with a minimum rpm of 320 and a maximum of 514. The gear ratio on this stand is 7.8 giving a roll rpm of 41 minimum and 66 maximum allowing a slab



speed of 271 feet per minute minimum, and 458 feet per minute maximum. The distance from No. 2 to No. 3 stands is 52 feet 6 inches.

No. 3 stand, with the same roll arrangement as No. 2, is also driven by a 3000 hp motor having an rpm of 514. The gear ratio on this mill is also 7.8 giving a roll rpm of 66 which allows for a strip speed of 436 to 458 feet per minute. The distance from No. 3 to No. 4 roughing mill stands is 82 feet 6 inches. The No. 4 and last roughing mill, having the same roll arrangement as the preceding two stands, is driven by a 3000 hp motor having an rpm of 514. The gear ratio here is also 7.8 giving a roll rpm of 66 allowing the material to pass through this stand at approximately 436 to 466 feet per minute. Immediately ahead of each No. 2, 3 and 4 roughing mills, and on the entering side is an edging mill of the integral type driven by a 150 hp motor, having a minimum rpm of 450 and a maximum of 900. The roll rpm is 38.79 minimum and 77.59 maximum giving a feet per minute speed of 198 fpm minimum and 447 maximum.

The distance between No. 4 roughing stand and No. 5 or the first finishing stand is 122 feet. Here immediately preceding the No. 5 finishing stand is located the crop shear for cropping the ends of the bar before it enters the mill, and also the last hydraulic spray for cleaning and removing the secondary scale that has arisen between the last rougher and the first finisher. The six finishing stands are all located on 18 foot centers. The first 5 mills are all driven by 4500 hp motors, each having a motor rpm of 125 minimum and 250 maximum. The gear ratio decreases on each of the stands in sequence to compensate for the faster speeds required on each stand with the exception of the fifth finishing stand which is a direct drive so that here we have the same roll rpm as the motor, or 125 rpm minimum and 250 rpm maximum, giving this mill a minimum speed of 826 fpm and 1734 fpm maximum. The sixth and last finishing stand is driven by a 3000 hp motor having an rpm of 175 to 350. The gear ratio here is 1.193 which gives a roll rpm of 146.69 to 293.38 allowing strip speeds of 970 fpm to 2035 fpm.



Now let us follow a slab through this modern mill we have just described. At a signal from the assistant rougher to the charger in back of the furnaces, by means of an electric light, a slab is entered into the furnace on the charging side. This action causes a slab to be discharged from the exit side of the furnace onto the table rolls running at right angles to the furnaces. Travelling along this table line, the slab comes to the scalebreaker located ahead of the roughing mill. Entering the rolls at the scalebreaker, the slab gets a light pass which causes the scale to crack and be washed off by the action of the hydraulic spray which hits the slab on both top and bottom side as it comes out of the scalebreaker.

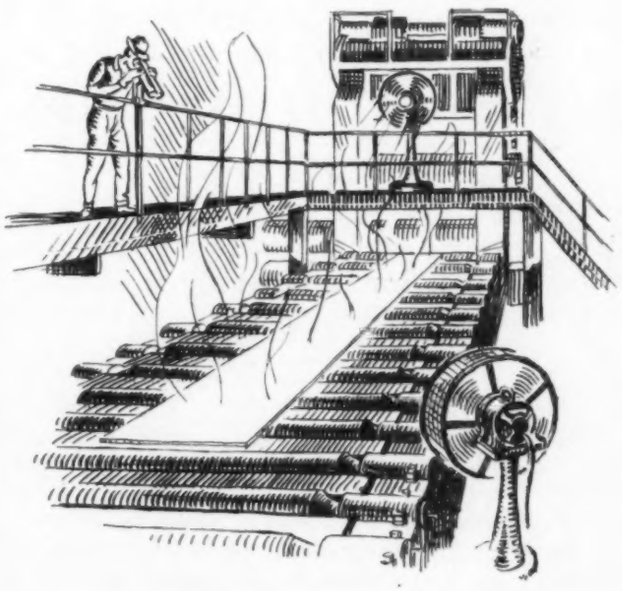
If the slab is to be cross or spread rolled, the operator now positions the slab directly above the lifting ram in front of the mill, turning the slab 90 degrees and enters it into the first roughing stand in this position. The slab is then stopped at the slab squeezer and the operator now trues up the slab from the distorted position it has assumed from the heavy draft it has been subjected to in the first stand. At this point, the strip mill operator begins to make his first move to control the width of the slab. Moving on through the first edging mill, the slab is fed into the second roughing mill and likewise through the third and fourth roughing stands elongating, in direct ratio to the percentage of the reduction. Here the slab comes to the long holding table where the table operator allows it to come to a predetermined temperature which is recorded by a recording temperature instrument. It is important that all of the slabs enter the first finishing stand at this predetermined temperature in order that the finished gauge may be uniform and also to control and insure getting the desired physical properties so necessary if the finished product is to give the customer the desired results.

At this point the front end of the bar is cropped on the rotary crop shears before entering the first finishing stand. This is to insure getting a good square front end. After entering the first stand the bar is always in several of the finishing stands at one time. The maximum elongation possible on the finishing train equals the maximum speed of the last stand divided by the minimum entry speed to the finishing train. Conversely, the minimum elongation equals the minimum speed of the last stand divided by the maximum entry speed of the train. The intermediate stands must accommodate the speeds produced by the elongations consistent with good drafting practice. The drafting or setting of mills in the hot mill necessarily varies widely due to variations in slab size, in mill condition, in product size, and in desired finishing temperature. Naturally the greater the elongation required between the slab and the strip,

the greater the reduction must be in each mill stand. Also, metallurgical requirements may dictate definite finishing temperatures which can be controlled to some extent by mill drafting.

4. *Delivery of steel* — After leaving No. 10 stand, or the last finishing stand, the strip is delivered onto a long runout table where it is carried to either the coilers or the sheet piler depending on the order. Here too the strip is subjected to cooling arrangements before coiling or piling in order to secure the desired results. Finishing temperatures of strip leaving the mill determine metallurgical qualities of the product. No definite temperature can be set, as analysis and subsequent processing must be considered. Generally the hot rolled strip should have a uniform normalized grain structure out of the mill, and should be coiled at temperatures low enough to prevent grain growth. Usually the strip temperature is dropped lower than that required for physical properties by sprays on the runout table, so as to avoid a formation of secondary scale or oxide which is difficult to remove by pickling. In cooling down to atmospheric temperature the strip shrinks materially in width and length. This shrinkage amounts to about 1 per cent or roughly $\frac{1}{8}$ in. per foot and allowances are made for this in obtaining width and length tolerances. Shrinkage in gauge is negligible and is commonly disregarded.

In conclusion, the production of hot rolled strip steel on a modern mill is one of the truly remarkable accomplishments of the steel industry. For from this production come so many things that make for a better standard of living for all our people, the modern automobile, trucks, refrigerators, electrical appliances, cans for containers, and many other articles too numerous to mention which have their beginning in the tonnages produced on a modern strip mill.



DISCUSSION

PRESENTED BY

E. L. PATTEN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

PAUL CARNAHAN, Assistant General Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

J. A. SHIMMIN, Superintendent of Maintenance, Rotary Electric Steel Company, Detroit, Michigan

D. E. McGUIRE, Chief Draftsman, Great Lakes Steel Corporation, Ecorse, Michigan

J. L. BUELL, JR., District Manager, Reliance Electric and Engineering Company, Detroit, Michigan

P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan

N. E. ROTHENTHALER, Metallurgical Engineer, Ford Motor Company, Dearborn, Michigan

FRANK BAMPTON, Superintendent, Blooming and Strip No. 1, Great Lakes Steel Corporation, Detroit, Michigan

ROBERT BELT, Chief Industrial Engineer, Great Lakes Steel Corporation, Detroit, Michigan

S. P. CHUNN, Great Lakes Steel Corporation, Ecorse, Michigan

H. W. ARAUZ, Minneapolis-Honeywell Regulator Company, Detroit, Michigan

H. F. LESSO, Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Michigan

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

E. L. Patten: What is the percentage of reduction on the strip between the first and last finishing stand?

Paul Carnahan: That varies, but I would say on an average the percentage of reduction would probably be somewhere between fifty and sixty to one.

J. A. Shimmin: I would like to ask if both a scale-breaker and a high pressure spray are essential for a clean strip?

Paul Carnahan: We feel so.

D. E. McGuire: The flying shear has a hydraulic generator and a hydraulic motor. It is a water-bearing drive. There is a knife in the bottom drum, and a knife in the top drum. Those drums are of two different diameters, and the relative motion of the revolution of each drum regulates the length of the strip that is cut; that is, the bottom drum may pass several times the top drum knife without cutting. The speeds of the two are regulated in order to give you your designated length of strip. The knives only match to give you the length that you want. I don't know if that is very plain or not, but if you take two drums of unequal size and revolve them at different rates at one point in their revolution the knives will match and by changing the revolution and the speed of each of these drums so

that they match at intervals, that governs the length of the strip.

J. L. Buell, Jr.: I would like to ask whether the width of the sheet is controlled entirely from one set of edging rolls, following the first roughers or do you have additional edging rolls as the strip does down through the roughing and finishing stands.

Paul Carnahan: There are three verticals one of each located ahead of the second, third, and fourth roughing mills. There are no vertical rolls in the finishing train. Of course I might say further that the width of the slab also has a great bearing on the width of the strip.

P. E. Haglund: By the way of interest, I would like to ask the rolling mill men a little about the defects in sheet steel put in there by the hot rolled strip mill. I heard about the defects from the open hearth, but I want to know about the defects put in there by the hot rolled strip mill.

Paul Carnahan: Our contention is that we put no defects in the steel in rolling it. Of course, that is open to discussion.

I might say that some of the surface defects can be eliminated by securing the proper scale jacket in the reheating furnaces, and the correct removal of the same by the action of the hydraulic sprays.

N. E. Rothenthaler: Metallurgically, what do you find in the sheet piling with regard to hardness and structure?

Paul Carnahan: Due to the increase in length of the run-out tables from the coiler to the sheet piler, we can, by speed control combined with the water sprays, regulate the temperature at which we pile. As I say, the type of the steel and customer specifications govern to a great extent the piling temperatures.

Frank Bampton: I wonder if the author would be interested in giving us his version of the furnace bottom. On the bottom side of the slab there is scale and there is a lot of controversy as to the cause of this.

Paul Carnahan: I might say that our experience has been, of course, that you don't get the scale condition on the bottom of your slab that you do on the top. That is, you can't control the scale condition to the same degree that you can the top of your slab due to the fact that, through the soaking zone, the slab is riding on the hearth of your furnace. I would say that in this unit we haven't had too much trouble from scale condition on the bottom side. I think probably the temperature of the slab as it enters the soaking zone has a great deal to do with the control that you can maintain over this condition on the bottom of your slab.

Robert Belt: I would like to know the water pressure of the sprays.

Paul Carnahan: Approximately a thousand pounds per square inch.

S. P. Chunn: What is the average speed of the strip when it comes out of the last mill stand?

Paul Carnahan: It depends of course on the percentage of reduction, and the finishing temperature desired. I would say on the average that the finishing speed is somewhere in the neighborhood of 1450-1500 fpm. It may be higher or it may be lower, depending on the product being made.

S. P. Chunn: Is it governed to some extent by the metallurgical process of the steel?

Paul Carnahan: That is a factor as is also the size of the slab, which in turn governs the amount of material that you have to take away from each succeeding stand.

H. W. Arauz: At Lukens Steel Corporation I saw them throw damp rags on the strip as it comes out of the mill. Is that a general practice and does that help descaling of the sheet?

Paul Carnahan: I presume you are talking about a plate mill, and that the mill that you are speaking of is a mill that is rolling plate?

H. W. Arauz: Yes.

Paul Carnahan: I believe that it is common practice around the old type plate mills, to use rags and salt and many other things to produce the cracking effect that loosens the scale.

H. W. Arauz: Is it ever done in sheet mills?

Paul Carnahan: No, it is all done by hydraulic descalers.

H. F. Lesso: Is there any established relationship between strip or slab width and mill speed and if such a relationship does exist, what are the fundamental considerations?

Paul Carnahan: No, the established relationship is between strip or slab thickness and mill speed.

L. R. Milburn: I think what Mr. Lesso means is this: if you are rolling thirty inch wide material at nineteen hundred feet a minute, you can roll sixty inch wide at that same speed if your mill is working right.

Paul Carnahan: If we want to.

L. R. Milburn: You don't have to slow down, when you increase the width.

Paul Carnahan: No.

L. R. Milburn: As long as your mill is working right, you can go on up to ninety inches wide.

Paul Carnahan: We can, but generally we do slow down on wider widths. The gauge is the dominant factor in calculating speeds; in other words, the gauge finishing temperature desired is probably a greater factor in determining speed than width.

AISE

BUFFALO DISTRICT SECTION

MAY 13, 1947

DINNER — 5:30 P. M.

INSPECTION TRIP — 6:30 P. M.

TECHNICAL MEETING — 8:00 P. M.

WESTINGHOUSE ELECTRIC CORPORATION
MOTOR DIVISION PLANT
4457 GENESSEE STREET
BUFFALO, NEW YORK

SUBJECT OF TECHNICAL MEETING: "The Manufacture of Mill Type Motors" by C. B. Hathaway, Westinghouse Electric Corporation.

Reservations must be made to: H. C. Lindberg, District Secretary, AISE, 535 Washington Street, Buffalo 3, N.Y.

CENTRALIZED LUBRICATION IN INDUSTRY

. . . . centralized lubrication systems pay dividends through elimination of bearing repairs and lost production, as well as through man-hour savings and lowered oil and grease bills . . . .

BY E. I. PFAFF, TRABON ENGINEERING CORPORATION, CLEVELAND, OHIO

▲ THE centralized lubricating field is felt to be one of the least publicized and most neglected aspects of American industrial operation today. Take the average machinery builder for example. He gets an order from a Detroit automobile manufacturer to design and build a special machine for a highly important operation in the manufacturer's plant. He puts his extra special engineering talent to work. Fifty thousand dollars and six months later he ships the completed machine to Detroit. The machine works perfectly for three months. Then, because the lubrication man had the flu for a week, or because he was not educated to do his job properly, or because he was simply too lazy to crawl down below the floor level and grease a hard-to-get-at bearing, the bearing burns out and the machine breaks down. Inasmuch as it is a special machine it takes several days to effect repairs.

What does it all add up to? The auto manufacturer loses highly important production at a time when he can least afford it, and the lubrication man gets fired, unless he belongs to the right club. The machine builder is blamed for building a shoddy machine! But nobody seems to realize that the whole affair could have been prevented by a simple, relatively inexpensive centralized lubricating system.

The unhappy truth is that many machine designers of today equip tomorrow's machinery with yesterday's lubricating methods. Much time is spent designing the perfect bearing to do the job. Then a neat round hole is drawn and labeled "quarter inch pipe tap for lubrication," and promptly forgotten. Three months later the machine goes into somebody's plant and according to a whim of fate either gets properly lubricated or does not, frequently the latter.

I have been told that early in World War II German tanks out-gunned out-armored and out-mechanized the tanks used by our armed forces. They also out-lubricated them. For the Germans installed centralized lubricating systems on much of this equipment, while our tanks were tediously lubricated by hand, when and if they were lubricated at all.

It is hard to realize that pressure lubrication is a comparatively new industry. We have only to go back to World War I. About that time, the "Gulborg" pressure fitting and pressure gun were developed. The fitting was nothing more than a simple pipe nipple, one end of which was threaded into a bearing and the other end was provided with a cross pin onto which the coupler of a hand pump was attached. The hand pump was made up from a short piece of pipe with a threaded cap on one end and a coupler on the opposite end, with screw type plunger which forced the grease through the coupler into the fitting, thus permitting grease to be forced into the bearing under much higher pressure than was possible with the ordinary grease cup. This eventually became known as the pin type pressure lubricating system.

This system had hardly been perfected when World War I broke out. So instead of presenting their brain child to private industry, its sponsors contacted the U. S. Army and obtained their approval to equip army trucks then in production at the White Motor Company. When the White Motor Company returned to civilian production, they retained the pressure fitting as standard equipment, so became the first company to adopt pressure lubrication. Gradually, other manufacturers of automobiles followed suit.

Shop men who used and serviced trucks and automobiles soon began to equip, with pressure lubrication, hard to lubricate bearings on industrial machinery. Eventually industry in general began to adopt pressure lubrication. Centralized pressure lubrication was yet to come.

The automotive industry, closely followed by the steel industry, took an early lead in adopting and developing centralized lubricating methods. As far back as 1924 one of the largest automobile manufacturers directed his plant engineering staff to make a survey of lubricating needs in order to minimize losses in produc-

Presented before AISE Detroit District Section Meeting, March 19, 1946, and AISE Birmingham District Section Meeting, April 29, 1946.

tion time caused by inadequate lubricating methods and their accompanying breakdowns.

The first year following the survey, the company spent $100,000 with us in equipping old and new machinery with the old multiple tube system, an early form of centralized lubrication. By this method, individual tubing is run from each bearing to a central point where all are serviced with a hand gun. This company, following the first year of operation after these installations were made, claimed that they could trace a direct annual saving of $30,000 to better lubrication.

The old multiple tube system was a step in the right direction. It had the disadvantage, however, of making it impossible for the gun operator to know whether he was greasing each bearing properly unless he inspected each in turn, a time-consuming process. The average gun operator made a good guess and let it go at that.

Thus, the first attempts at centralized lubrication were far from perfect, and, in plants where it was absolutely imperative that grease or oil did not splash or drip on the product in process, the multiple tube system soon gave way to the earlier forms of controlled centralized systems, using feeders or metering units.

In the centralized feeder system, or, as it is sometimes called, the centralized manifold system, the lubricant, either grease or oil, is pumped through a main line or header to feeders or manifolds located at strategic points on the machinery to be lubricated. The feeder or manifold has one or more outlets, with each outlet serving a bearing.

In some cases, feeders are operated by spring action, in some cases by steadily increasing pressure, and in still others by the hydraulic action of the main flow of grease itself. In the latter type each feeder or feeder section operates progressively. The measuring piston in each section must complete its full stroke, forcing its charge of grease into the bearing line, before the main flow of lubricant can proceed to the next measuring piston.

Some systems are one-way systems while others are reversible. In the former type the lubricant flows from the pump through a single main line to the feeders where it is distributed to the bearings. In the reversible type, such as the one shown in Figure 1, the grease leaves the pump through one outlet of the hand reversing valve. Traveling through each feeder in turn it operates the measuring pistons which, in turn, force measured charges of grease or oil into the bearings.

Completing its circuit the lubricant returns to the pump, operating an indicator which tells the operator that the cycle is complete. He then throws the handle of the reversing valve in the opposite direction and pumps the lubricant around the circuit in the reverse direction. Should one of the bearing lines be blocked by a tight bearing or a clogged bearing groove, the measuring piston in that particular feeder will be unable to make a complete stroke and, in turn, will block the main flow of grease. The operator will be unable to pump further and, of course, the indicator will refuse to emerge. This gives the operator a positive "trouble signal". Note the wide variety of bearings served by this system. In the upper left hand corner we have another type of feeder or manifold. This feeder distributes the entire output of the main line feeder to a group of six bearings on a moving machine member. Note the single flexible hose connection. This type of feeder also operates progressively within itself and each measuring piston must serve its bearing properly before the grease can proceed to the next measuring piston within the feeder.

Centralized systems today can be operated by a simple hand grease gun, hand pump, a motor-driven pump or a pump driven mechanically by some oscillating or rotating part of the machine being lubricated. In the reversing system with a mechanically driven pump, the pump stops and starts with the machine. The pump incorporates an automatic reverser and operates from an overrunning clutch driven by the back and forth movement of the drive arm.

In Figure 2 are two one-way systems, one motor-driven, the other served by a small hand pump. In the

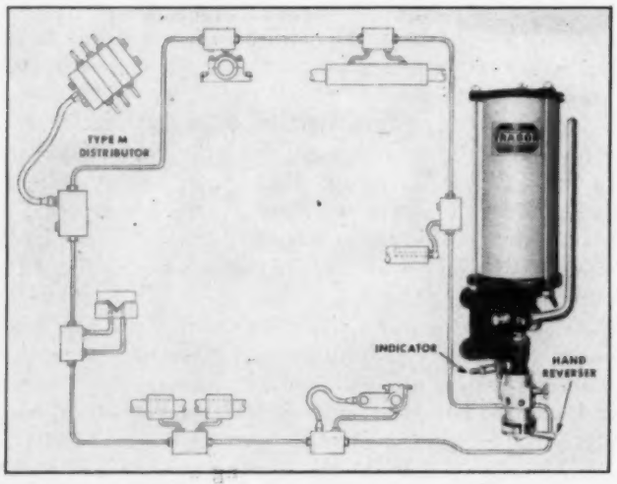


Figure 1 — This reversing, centralized, lubrication system has a hand operated pump.

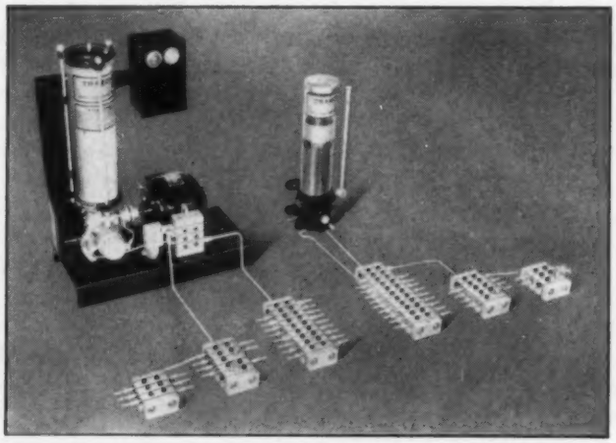


Figure 2 — Illustrated here are two one-way systems, one served by a hand pump, and the other by a motor-driven pump.

one-way system, the lubricant is usually pumped to a master feeder where it is distributed in measured amounts to subsidiary feeders, each handling from two to twenty-two bearings. The subsidiary feeders in turn measure and distribute their flow of grease to the group of bearings they serve. Each section of this feeder contains an individual measuring piston of varying size. These pistons operate progressively. Each must make a complete stroke, forcing its measured portion of lubricant out into the bearing line before the main flow of lubricant can proceed to the next measuring piston in the adjacent feeder section. This makes it impossible to underlubricate or skip a tight bearing.

In installing automatic systems it is usually desirable to provide some sort of signal to indicate whether or not the system is functioning properly. Some systems use an ordinary gauge in the line. By observing this gauge from time to time, the operator can tell whether the pump is operating efficiently and whether bearing lines are free and open. Another frequently used indicator is a two-light blinker signal. This signal is operated from a micro-switch actuated by back-and-forth movement of a measuring piston. The continuous blinking of the light indicates that the system is operating properly. Should the light freeze in one position, the operator knows that the system is blocked by a clogged bearing line or tight bearing.

Where large quantities of lubricant are required pumps delivering more volume are used. If continuous operation is not desired these pumps can be controlled by a timer which switches on the pump so many minutes out of every hour.

Over the last decade and a half, the nation's steel mills appreciating the advantages of centralized lubricating systems have been slowly but surely equipping most of their machinery with them. The heavy operating schedules of the war years emphasized these advantages. For instance, in one Ohio mill, stepped up production required 24-hour a day, seven day a week operation of an old blooming mill. The entering and delivering tables of this mill were equipped with 21 rolls running in brass bearings. These roll bearings, lubricated with hand gun methods could not stand the pace and it became necessary to shut down the mill every Sunday to repair an average of four bearings on these tables. The maintenance work required six or seven hours' time of five men and also the use of an overhead crane.

A centralized automatic system delivering a small quantity of grease every 18 minutes to these bearings was installed. Since its installation 18 months have elapsed since a Sunday shutdown, and the bearings have been kept properly lubricated despite the heat and pounding of the heavy blooms.

A well known forging plant in Chicago has now equipped approximately 30 Ajax upsetters with automatic lubricating systems and at a recent interview we were advised that during the past two years, since most of these upsetters have been equipped with a lubricating system, they have not lost a bearing and other maintenance expense has been cut more than 50 per cent.

Figure 3 shows an automatic system on a mill. Two push-button circuits feed lubricant to the table and an automatic circuit feeds the mill itself.

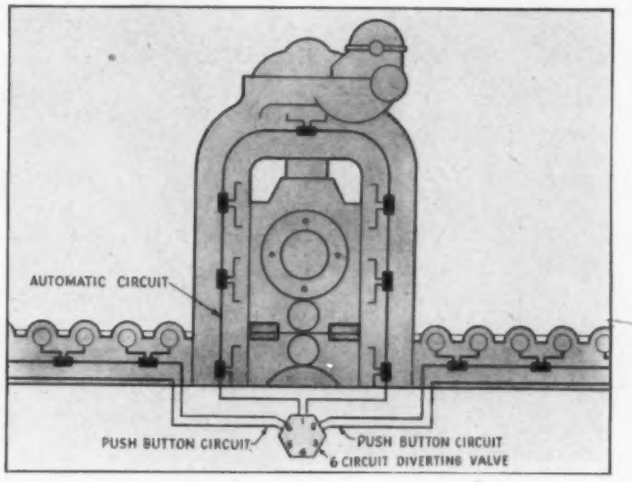


Figure 3 — Schematic diagram of lubrication system on rolling mill.

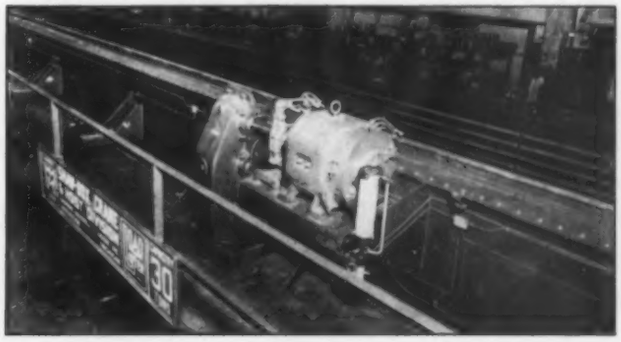


Figure 4 — Centralized lubrication on crane bridges has eliminated many of the former hazards in the maintenance of cranes.

It was estimated during the war that centralized lubrication on rolling mills saved hundreds of tons of critical bearing materials and thousands of precious man-hours. Centralized systems reduced power consumption by more than 10 per cent, increased bearing life from twenty to thirty times, eliminated down time for lubrication, reduced rejections from off-gauge rolling and increased daily tonnage by as much as 25 per cent.

Figure 4 shows a centralized reversible system installed on a crane bridge. Cranes, too, were kept on active duty during the war by centralized lubrication of bridges and trolleys. A mill in Ohio decided to rehabilitate an old crane that had been plagued for years by frequent breakdowns. The rehabilitation included the installation of new bearings and centralized lubrication. The system was installed during a production schedule which did not permit renewal of the old bearings. However, centralized lubrication did such a

good job for these people that the old bearings, untouched, are still going strong after more than a year following the installation of the system.

Figure 5 shows the installation of centralized systems on main and auxiliary trolleys of a large steel mill crane.

On large overhead cranes it has been figured that centralized lubrication will save $5.00 per day in oiling time alone. Automatic systems, driven from a revolving shaft, are particularly advantageous on such hard-to-reach equipment. As a matter of fact automatic systems are always advantageous on any type of machine because they eliminate the human element. Another important factor in connection with lubrication of cranes and similar equipment is safety. Not so long ago a crane operator in a steel mill slipped and fell while lubricating his crane. He left behind him a grief-stricken family and an $18,000 compensation bill. Needless to say, an order was quickly issued to equip this, and other cranes like it, with centralized lubricating systems.

Recently, at a plant in Chicago operating a number of cranes, the Union grievance committee had complained that the cranes were unsafe for the lubricating men since they were not equipped with catwalks and hand rails, and had insisted that these be provided. Rather than spend their money for walks and rails, the management decided that a centralized lubricating system would not only overcome the objections of the grievance committee but would also increase the efficiency of their cranes.

In a large seamless tube mill, the piercing buggy slides were finally equipped with a lubricating system. According to plant engineers power savings alone were 55 per cent.

And speaking of power savings, here is an excellent example of what automatic centralized lubrication can do. Power costs on a blooming mill during one year totalled $42,300. The output of the mill during this time was approximately 470,000 tons. After installing a centralized system on the roll necks, 630,000 tons of steel were rolled during the next twelve-month period for a total power cost of $37,170. Savings in power costs alone amounted to $5,900 per 100,000 tons rolled or almost $20,000 per year saved. The cost of the whole installation was less than $6,000.

On a lath mill in Youngstown, expander bearings were being lost at the rate of two or three a month. After a system was installed only one bearing had been lost in the two years following the installation.

Ore bridges, ore unloaders and blast furnaces are frequently equipped with centralized lubricating systems at tremendous savings in lubricating time and repair work. Centralized systems on outdoor installations using winter greases and oils seem to work just as efficiently in mid-winter as they do in mid-summer.

Figure 6 illustrates centralized lubrication of a bonderizing line. Note the hand pumps located at intervals along the machine. Evidently there were enough bearings to require several circuits.

Centralized lubrication systems are of particular advantage in the lubrication of extended lines of bearings such as are found in continuous annealing furnaces, pickling and cleaning lines and other types of conveyorized equipment.

Where bearings are exposed to continuous enclosed heat such as might be found in tire cord dip units, centralized systems are adjusted to operate continuously. A small-volume pump with adjustable discharge actuates the flow of oil or grease so that the feeder section deposits small droplets of the lubricant on each bearing at intervals of a few seconds. This type of lubrication is also used on high speed machine tools and possesses many of the advantages of a circulating oil system without its complications. These pumps may be motor-driven or driven from the machine itself, from an oscillating or revolving part.

Press operators who have specified centralized systems have been reaping the benefits of it especially during the last four war years. For example a large press in a Cleveland shop has been on 24-hour duty for over a year and a half. Prior to installation of a centralized system the press was frequently down for repairs. During the year and a half of continuous operation since that time there have been no shutdowns.

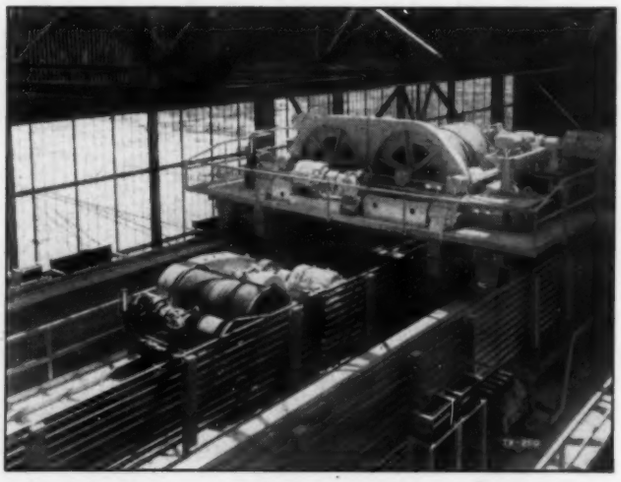


Figure 5 — Both the auxiliary and main trolleys of this crane are lubricated from a centralized system.

Under optimum conditions upwards of a hundred bearings can be handled from a single circuit. Systems are usually designed so that maximum pressure, even in cold weather, does not exceed 3000 lb. Where lines are unusually long, larger diameters of pipe and tubing are used to reduce line pressure. The feeders themselves, necessarily constrict flow and must be taken into consideration in figuring the limits of large systems.

An interesting application of automatic centralized lubrication is a wind generator located on Grandpa's Knob, Vermont. The giant, two-bladed propeller has a wingspread of 175 feet. An automatic feathering device permits it to handle wind velocities from 18 to 60 miles per hour. It is now helping to supply Rutland's power requirements. The wind generator is shut down every six months for servicing. The grease reservoir is replenished at that time. It now has six years of service and no bearing failure to our knowledge. The lubricating

system is still going strong despite mid-summer temperatures of 100 and mid-winter temperatures of 40 below.

The terrific loads of machines such as ore crushers are also a natural for centralized lubrication where a continuous flow of lubricant is essential for bearing life.

I remember one case where the water-cooled bearings on a heavy-duty crusher were being lubricated, but not satisfactorily, with a hand system. Automatic lubrication was submitted and it has done such a thoroughly satisfactory job that the water-cooling has been eliminated and the crusher is still able to handle very heavy loads without over-heating the bearings.

Entirely new fields are being invaded by centralized lubrication. The time-honored figure of the oiler on the lake freighter, the grease monkey in the coal mine, these, and others, will be slowly but surely superseded by automatic lubrication. The future of centralized lubrication is as certain as tomorrow's sunrise. It is not too optimistic to assume that five years from now instead of waiting an hour at the corner filling station

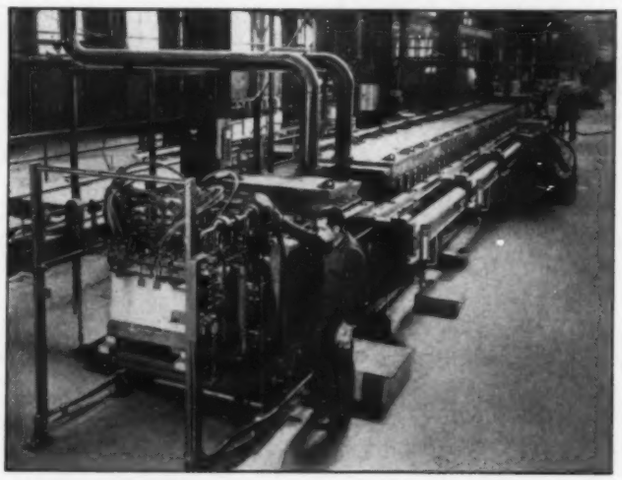


Figure 6 — This bonderizing line required several circuits for its lubrication system.

for your car to be greased you will drive in and say, "ten gallons of gas, a quart of oil, and a shot of grease!" The attendant will hook his portable pump to your centralized lubricating system and in a moment you will be back on the highway heading for the country club. Or better still, an automatic pump will lubricate your car continuously as you drive along.

Machinery manufacturers, slowly but surely, are standardizing on some form of centralized lubrication, knowing that it increases the saleability of their product and realizing that it inevitably adds up to more satisfied customers over the years. Machinery users are finding that it pays to put centralized lubrication systems on old as well as new machinery. They have discovered that it pays big dividends in the elimination of bearing repairs and lost production time, in lowered oil and grease bills and man-hour savings, in lowered compensation costs, in protecting their plant investment by keeping machinery young, and, finally in eliminating that unpredictable and frequently costly human element.

DISCUSSION

PRESENTED BY

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

E. I. PFAFF, Sales Manager, Trabon Engineering Corporation, Cleveland, Ohio

J. A. SHIMMIN, Superintendent of Maintenance, Rotary Electric Steel Company, Detroit, Michigan

W. H. COLLISON, Superintendent Coke Plant of Blast Furnace Division, Great Lakes Steel Corporation, Ecorse, Michigan

V. A. Smith, Industrial Sales Manager, Socony-Vacuum Oil Company, Inc., Detroit, Michigan

C. E. S. EDDIE, Assistant Superintendent Power and Fuel, Great Lakes Steel Corporation, Ecorse, Michigan

L. DUNN, E. F. Houghton Company, Detroit, Michigan

H. H. BARROWS, Manager, Industrial Equipment Company, Detroit, Michigan

C. S. ABBOTT, J. N. Fauver Company, Detroit, Michigan

O. P. ASHURST, Engineer, Giffels and Vallet, Inc., Detroit, Michigan

JOHN SCHRAMM, Socony-Vacuum Oil Company, Trenton, Michigan

J. A. RIGBY, Chief Engineer, The Brooks Oil Company, Cleveland, Ohio

L. R. Milburn: What are you doing or planning to do to locate plugged bearings?

E. I. Pfaff: It is quite simple to locate trouble. Our reversible type system is provided with a single indicator at the pump which is actuated by the return of lubricant to the pump after all of the bearings have received their measured amount of lubricant. If there were a plugged bearing or crushed line in the system, the lubricant could not return to the pump to operate the indicator. On a hand operated system, the pump would also lock so that the operator would be unable to continue pumping. Dirt, steel chips or any foreign substances in the grease are the worst enemies of any centralized lubricating system. If the pump locks, it could be possible that a small steel chip had prevented movement of one of the pistons in a feeder and this can often be corrected by merely reversing the system and pumping in the opposite direction, thereby clearing the chip from the valve port. On a hand operated system, if the operator is familiar with the system, he probably knows it may take ten to fifteen strokes to complete his circuit. If he has only pumped five or six strokes and the system blocks, he then knows he has only gone about one-third of the way around the circuit in the direction in which he is pumping and often can very quickly locate the particular point that is blocked.

Trouble in a centralized lubricating system might be compared to an electric light circuit. In other words, if

you have trouble it is more or less a process of elimination. All Trabon feeders are provided with test plugs and he would eliminate one-half of his circuit by going to the center and opening a test plug. If it is clear to that point, he has eliminated that portion of the system. He would then follow the same process of elimination with the balance of the circuits until he located the point of trouble.

Other causes of trouble in centralized lubricating systems are crushed tubing, and this can be quickly detected by an inspection of the system. We find that operators who are familiar with our systems can locate trouble very quickly. Fully automatic systems are provided with various types of warning signals and if trouble is encountered, the same process would be followed in locating trouble.

J. A. Shimmin: What happens when there is a broken line and no pressure?

E. I. Pfaff: I might have missed the simplest method of locating the trouble. Naturally, the thing to do with any lubricating system is to look for the broken line. Simple inspection often finds those lines are crushed and by taking the crushed line out and putting in a good one, you have eliminated the trouble.

If the line is open in the main circuit, it is possible to detect that immediately, because it would not be possible to complete the circuit which operated the indicator. We must complete the circuit, and to complete the circuit there must be a flow of grease back to the pump to operate the indicator. If there is an open line between the feeder and the bearing, you just have to find it. There is no way, in a centralized lubricating system, of detecting an open line between the feeder and the bearing, unless you see the grease coming out of it. There might be a way of doing it. You might put on some electrical device where the heating of the bearing would be an indication. As far as we see it at the present time, the disadvantages of such a device are far in excess of the advantages of it. The average bearings on most equipment, if they fail to be lubricated for one or two operations would not burn up. We don't recommend lubricating your machine that close.

J. A. Shimmin: If the line between the bearing and the feeder were open, would that affect the rest of the system?

E. I. Pfaff: No. You would simply pump the grease out in the open. If for some reason the tube were cut in two, it would just carry it out in the open, and you would see the grease coming out. If the line between the feeder and the bearing were crushed this would be indicated.

W. H. Collison: I would like to ask what types of greases are most suitable, and, in a general way, the limitations or specifications for greases.

E. I. Pfaff: I would definitely recommend that you consult your regular supplier of lubricants, who is in a position to recommend the proper lubricant for your machine and also one that will work satisfactorily in a centralized lubricating system. You have certain limitations, of course. You cannot pump a real hard grease like a bar of soap. We usually specify a type of lubricant that will operate satisfactorily in any pressure gun. Ordinarily if you take the problem up with your supplier of lubricant, he will provide you with the proper product.

V. A. Smith: Are they likely to be a lime base or soda?

E. I. Pfaff: Either lime or soda base greases can be pumped, if of the proper consistency. However, with the introduction of centralized lubricating systems you will find that lighter base greases can be used. If you will remember back a few years ago, block greases were used on mill stands. Today they are using soft grease and this lubricant is doing a better job. In other words, lubrication may be considered 50 per cent product and 50 per cent introduction. The best grease in the world can do no good if it does not get into the bearings. With centralized lubricating systems you can lubricate many bearings in a few seconds. Particularly with an automatic system, the lubricating cycles can be more frequent, introducing smaller quantities of grease with each application.Smaller quantities of grease at frequent intervals will give better lubrication than to try to introduce enough lubricant at a time to last for several hours.

Another important thing that should be kept in mind is that the lubricant should be kept clean. Dirty grease can cause trouble in both the centralized lubricating systems and bearings being lubricated.

We try to avoid getting dirt into the system by furnishing sealed reservoirs on our pumps. These pumps are also provided with screens for filtering the lubricant; also, the containers which we provide for filling them are equipped with screens to keep the grease as clear as possible before it leaves the container.

C. E. S. Eddie: I think Mr. Collison had in mind a blast furnace installation. He has this long line business in mind, where the high pressure pumping system is located at operating level and the valves are way up in the masthead.

E. I. Pfaff: We have centralized lubricating systems installed on outdoor cranes and blast furnaces, where they are operating at low temperatures. On outdoor installations such as furnaces, etc., and where you have long lines, it is a good idea to run a steam tracer line alongside the grease line. On certain other installations we have used electric heating elements to keep the grease in long lines from congealing.

We have installations on blast furnace tops in Canada and Duluth, Minnesota, and on gold and platinum dredges in Alaska, and with the proper care and precautions, all are giving very satisfactory service at extremely low temperatures.

L. Dunn: How do you handle a hot bearing, where the heat is not caused by friction but is a result of location.

E. I. Pfaff: The feeder or metering unit in this case could be placed some distance from the bearing.

L. Dunn: Would the pistons in the feeders have a tendency to jam?

E. I. Pfaff: It would have to be a condition where there was considerably more than ordinary heat. If you have a condition where heat is going to affect the feeder, the sensible thing to do would be to place the feeder as far from the heat as possible. If you have enough heat to affect the feeder, a long lead line could be used

between the feeder and the point of lubrication, as the lubricant would move freely because of the heat.

C. E. S. Eddie: You mention on air mill generator shutdown. I am wondering why the plant had to be shut down in order to add grease to the system.

E. I. Pfaff: The wind generator apparently was an experiment. Fearing that some day there wouldn't be sufficient coal or water power, it would provide a cheap method of getting power. The company in Cleveland who built the unit were presented with the problem of how to lubricate it as they did not want to shut it down more often than every six months. In furnishing the pump, we provided a large enough reservoir to provide sufficient grease for that period of time, as it was decided that the windmill would have to be shut down at least that often for other purposes and they did not want to have to stop the wind mill to fill the grease reservoir.

C. E. S. Eddie: If they decided to run the mill longer than six months, would there be sufficient lubrication?

E. I. Pfaff: As I remember it, it was hard to get up to the windmill to lubricate it and they asked for a system that would supply lubricant for a period of six months. Lubrication for a longer period would have been furnished if it had been requested by the manufacturer.

We have had many interesting problems come up such as a method of indicating when the grease reservoirs on the pumps run empty. Several years ago, during the war, we equipped a large jaw type crusher at a metallurgical plant in Pennsylvania. This crusher had been equipped with a fully automatic motor driven lubricating system. Before starting the crusher in service, it was decided to run it in for a few hours. The men started it up one afternoon and whoever was responsible went home that night and forgot to stop the crusher. The next morning the crusher and grease pump were still running, however there was no grease left in the pump. The bearing had run fairly warm but had not burned out, so we got a rush call to put on some positive indication that would show when the grease was running low in the reservoir. Since our pump was equipped with a spring loaded follower and indicator rod, we put a micro switch at the top of the reservoir. When the grease in the reservoir reached a low point, it operated the switch which is arranged to turn on a light and give the operators sufficient warning in time to fill the reservoir before they run out of grease. The next thing they wanted to know was if we could not stop the crusher when the grease pump ran out of grease. This, of course, was simple to do by merely cutting the main power circuit to the switch so that when the level of the grease reached the danger point, it automatically stopped the whole unit.

H. H. Barrows: Before you leave the kind of lubricant that can be used in a centralized system, I believe that the point should be made that your answers have been given for the type of centralized systems which handle the lubricant entirely by hydraulic pressure, both for loading and discharging the valves.

E. I. Pfaff: That is right. What I said about variety of lubricants which could be used applied to this type of system.

H. H. Barrows: With the fully hydraulically operated system, the lubricant could range from glycerine to comparatively hard soap. The pump can be designed to push the lubricant selected through a given amount of circuit and number of valves of the feeder.

However, if you want to consider the use of a spring-operated feeder, that is, either the discharging or reloading of the feeder or valve by spring action, then the type of lubricant you are going to use is vital and must be given definite consideration.

I was one of the first men that sold the old multiple tube system, and during a period of some thirty years, I have sold many different systems, and I have seen the development from the multiple tube system through the spring-operating valve, and the hydraulically operated system, where you fill the cylinder with lubricant by hydraulic methods, and push it out and into the bearing by hydraulic methods. If you stick to the hydraulic type of system, you can handle almost any lubricant. When you get into a valve with a spring action, you must be careful of the kind of lubricant used, not only as to consistency, but whether or not it separates under pressure, and whether or not it changes in consistency too greatly under atmospheric changes. I think that is why types of lubricants should be given consideration.

E. I. Pfaff: I think that most of the systems sold are hydraulically operated. The mere fact that we do not use a spring-operated valve indicates we do not think much of it. Spring tensions vary. When our systems are being assembled at the factory, we have no way of knowing whether light or heavy grease will be used and under what temperatures they will be operated. A spring operated valve will operate differently under various temperatures and weather conditions. We are naturally sold on the hydraulic type of valves, however, I don't know that I should discuss the various types of systems. It would be well to discuss with you gentlemen the hydraulic operated feeders.

C. S. Abbott: One other point might be mentioned. It has to do with the question on the open line. We would like to see lubrication engineers on the job, and not grease monkeys. As good as these systems have become, there still remains the human element to work them. One of the first things you look to see is if there is grease getting into the bearing. The more automatic the system gets, the more important it is to have a man go around once a week who understands lubrication and checks things, and you have got to have a real lubrication engineer checking the system. You can run a whole plant with one good engineer and two helpers.

E. I. Pfaff: While mentioning the automatic system, I will say we are selling today more automatic systems than hand systems, and the trend seems to be toward the automatic system. It does eliminate much of the human element.

C. S. Abbott: The mistake made is putting automatic equipment on machinery and then forgetting it. There never was a piece of automatic equipment that did not need attention. It is dangerous to put automatic equipment on and not tell the operators they have to put the lubricant in, and that it should have periodical, intelligent inspection, even though it is automatic.

E. I. Pfaff: I think the point is very well brought up. I have spent a good many years selling and servicing

grease equipment. It seems to be a strange thing, but for some reason, when you sell a grease pump, the user seems to think it should operate without any trouble. I know that on some of the simplest power pumps we had service calls to check them, and on nine out of ten of the calls, there was nothing wrong but dirt in the check valve.

O. P. Ashurst: What provisions have been made for operating bearings at a different pressure?

E. I. Pfaff: None is necessary. In other words, in most of your good lubricating systems today, you have sufficient pressure. Most pumps are built to develop several thousand pounds pressure.

H. H. Barrows: We were talking about pressure in the centralized lubricating system. We only develop enough pressure to overcome the resistance we meet. Therefore, where many systems have a capacity of developing 1500 or 2000 psi, they may only require 20 or 30 psi, because that amount will overcome all the resistance in the circuit.

E. I. Pfaff: You only develop as much pressure with the system as you have resistance to work against.

L. R. Milburn: Suppose you have one bearing that takes ten pounds and another that takes fifteen in the same system.

E. I. Pfaff: It only gets its measured quantity.

H. H. Barrows: That is one of the greatest points of the centralized lubricating systems, to get the lubricant into the bearing while it turns. Failure to do this is discovered when you go into a filling station and find the shackle bolt of your car frozen, when you thought you had been lubricating it regularly. One of the greatest points of centralized lubricating systems is getting the lubricant into the bearings of the machine while they are running. The lubricant does not meet the resistance to flow into the journal that you have when the machine is standing still. It also spreads more evenly over the area to be lubricated.

There is another thing. Oftentimes there is an anti-friction high speed bearing that is well housed, or closely fitted, and you can get in too much lubricant and overheat. I had this experience a good many years ago in the Fisher Body Company. We had to use a light oil on high speed anti-friction bearings, and very little of it, only a mist which was just enough to keep the bearing wet with oil.

In some equipment we encountered overheating where we found the bearing well housed, if the lubricant was being forced in under high pressure because of the resistance from no vent in the housing, and the housing was getting too much lubricant in there. Venting the housing would permit excess lubricant to come out, and ordinarily relieve the internal pressure of the lubricant in the bearing, and stop the overheating.

John Schramm: Will you tell me what you find mostly when the line is blocked up?

E. I. Pfaff: Dirt in the grease ordinarily blocks up circuits, or foreign material in the grease. That may be due to any one or many different reasons. It may be careless handling for one.

We had an unusual experience a number of years ago. The system had to be almost calibrated to provide the proper lubrication to various bearings. We got a number of complaints that the pistons were cut and scoring in spite of all precautions and the fact that the builder had done his very best to avoid it and even built a house over the pump. They didn't blame us. They knew they were getting something in the grease. We had done everything possible to keep abrasives out of the lubricant; however, itfinally developed that abrasive dust in the air was accumulating on the workman's hat and clothes. In stooping over to get grease out of the grease drum, the abrasive dust fell off his hat and clothes into the grease. So that in spite of all the precautions we had taken, this bit of carelessness on the part of the workman caused all our trouble. It then became necessary to go all the way back to the original container, seal it, and provide a pump to transfer the grease to a portable container.

J. A. Rigby: In the numerous examples which have been illustrated it will be possible for many executives and engineers of industry to realize the necessity for extension of such systems in not only new equipment but in existing equipment.

Manufacturers of lubricants are vitally interested in this subject because their efforts are not only to supply quality lubricants, but to encourage the most economical use which is hardly practical by antiquated hand methods. Assurance that every bearing on a machine will get a predetermined dosage of lubricant and at regular intervals with the logical lubricant is the method to be desired for the best results from any machine.

Recent surveys have shown a preference of 85 per cent for new machines to be equipped with centralized lubrication. In the advertisements of such machines and from inspection of many which have been installed in recent years, it is most consoling to find that the trend for centralized lubrication is most pronounced.

With old equipment, some of which has been in service for up to 50 years, prewar and wartime necessities in continuity of operation, excessive overloading, and efforts for decreased maintenance costs created another field for centralized lubrication which has been pronounced in effect. In rolling mill service, this has been particularly noticeable in speeding up of production and reduction of maintenance cost.

Shortage of labor and particularly of the better classes, together with the fact that normally low priced labor is used as the element in applying lubricants has also been of aid in the extension of centralized lubrication. Hit and miss methods with excessive waste of products such as lubricants which are derived from our natural resources, and which may demand economy for conservation in the future are other essential reasons for centralized lubrication.

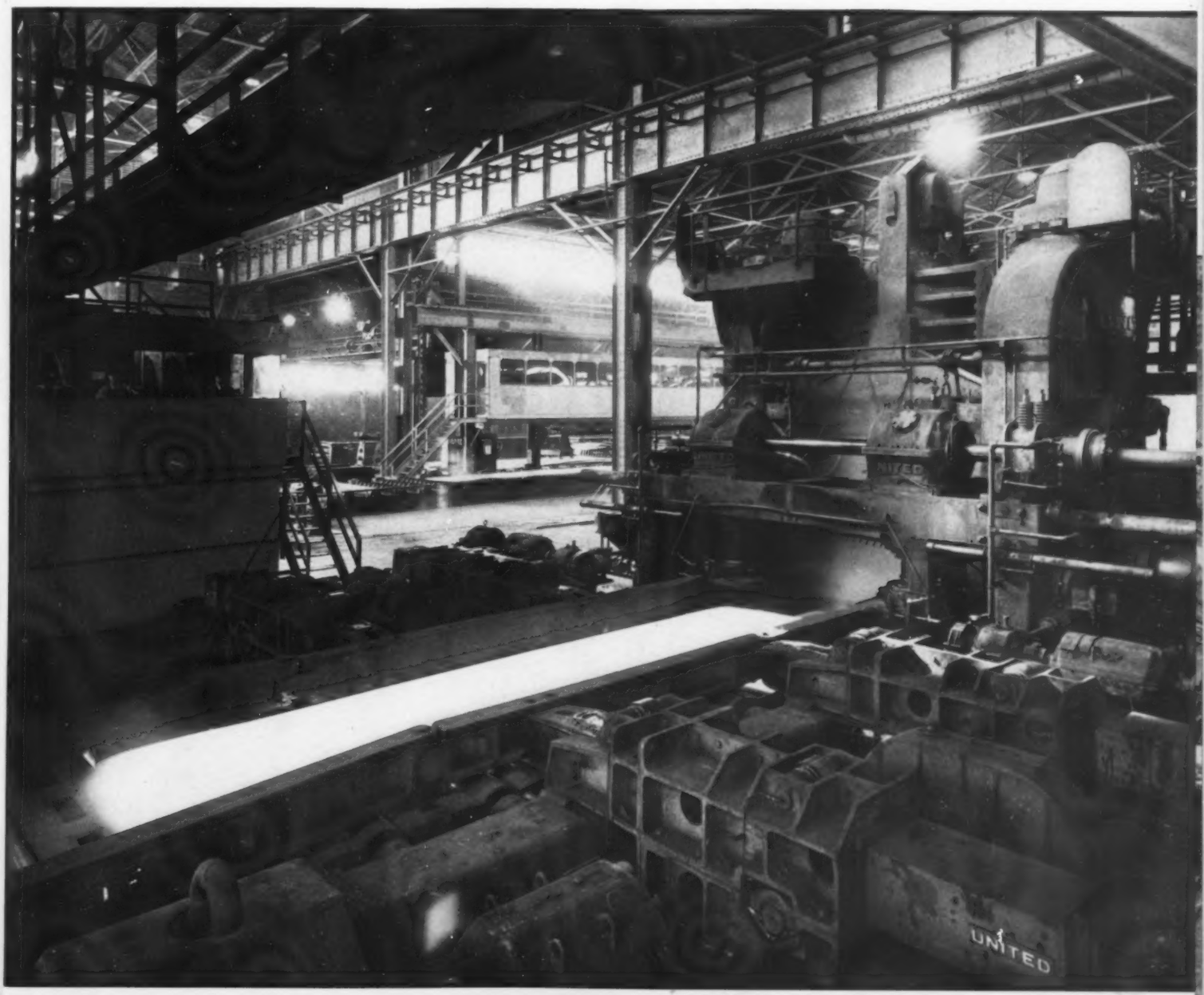
ANNUAL SPRING CONFERENCE

SPONSORED BY THE ROLLING MILL COMMITTEE

ASSOCIATION OF IRON AND STEEL ENGINEERS

MAY 26 - 27, 1947

BENJAMIN FRANKLIN HOTEL *PHILADELPHIA, PENNSYLVANIA*



PROGRAM

Monday, May 26, 1947

9:00 a.m. — Registration — Mezzanine Floor

10:00 a.m. — Technical Meeting — Crystal Ball Room

Co-Chairmen:

Anders G. Ericson
Chief Engineer, Homestead Steel Works
Carnegie-Illinois Steel Corporation
Munhall, Pennsylvania

Louis Moses, Superintendent
Rail Mill and Roll Departments
Bethlehem Steel Company
Sparrows Point, Maryland

"DESIGN, CONSTRUCTION AND LUBRICATION OF MILL COUPLINGS AND SPINDLES," by William L. Stover, Mechanical Engineer, Mesta Machine Company, Pittsburgh, Pennsylvania.

"THE ART OF ROLLING OCTAGONS AND HEXAGONS," by Charles P. Hammond, Superintendent, Rolling Mills, Atlas Steels Limited, Welland, Canada.

10:00 a.m. — Technical Meeting — Betsy Ross Room

Co-Chairmen:

C. R. Hand, Assistant Superintendent
Mechanical Department
Bethlehem Steel Company
Sparrows Point, Maryland

I. N. Tull, Electrical Superintendent
Republic Steel Corporation
Corrigan-McKinney Works
Cleveland, Ohio

"BEARING CONSTRUCTION AND PERFORMANCE," by E. Crankshaw, Assistant Chief Engineer, Cleveland Graphite Bronze Company, Cleveland, Ohio.

"WELDING OF STEEL STRIP FOR CONTINUOUS COLD ROLLING," by Henry Griffith, Welding Engineer, Federal Machine and Welder Company, Warren, Ohio.

2:00 p.m. — Technical Meeting — Crystal Ball Room

Co-Chairmen:

N. C. Bye, Director of Engineering
Henry Disston and Sons, Inc.
Philadelphia, Pennsylvania

S. C. Read, Superintendent, Rolling Mills
Jones and Laughlin Steel Corporation
S. S., Pittsburgh, Pennsylvania

"REMOTE CONTROL OF CONTINUOUS SLAB HEATING FURNACES," by C. E. Duffy, Assistant Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

"ROLLING PRACTICE ON 44, 36 and 32 INCH MILLS," by R. F. Lavette, Superintendent, 44, 36 and 32 Inch Mills, Republic Steel Corporation, Chicago, Illinois.

"THE MANUFACTURE OF WROUGHT STEEL WHEELS," By Robert Merk, Assistant to Chief Engineer, and William Ashton, Superintendent, Wheel and Axle Division, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania.

2:00 p.m. — Technical Meeting — Betsy Ross Room

Co-Chairmen:

M. B. Antrim, Technical Assistant to Electrical Superintendent
Lukens Steel Company
Coatesville, Pennsylvania

F. C. Schoen, Plant Engineer
The Midvale Company
Nicetown, Philadelphia, Pennsylvania

"POWER REQUIREMENTS FOR COLD DRAW BENCHES," by G. W. Garwig, Sales Engineer, Aetna-Standard Engineering Company, Youngstown, Ohio.

"CONTROL REQUIREMENTS FOR SPEEDING UP STRIP MILLS," by F. Mohler, Patterson-Emerson-Comstock, Inc., Pittsburgh, Pennsylvania.

"PROGRESS IN ELECTROLYTIC TINNING," by H. P. Munger, Superintendent, Tin Finishing Department, Youngstown Sheet and Tube Company, East Chicago, Indiana.

7:00 p.m. — DINNER — Crystal Ball Room
Speaker: Robert W. Wolcott, President,
Lukens Steel Company,
Coatesville, Pennsylvania.

Tuesday, May 27, 1947

INSPECTION TRIP

LUKENS STEEL COMPANY

COATESVILLE, PENNSYLVANIA

Buses will leave Benjamin Franklin Hotel, Philadelphia at 9:00 A. M., Tuesday, May 27, 1947. Evidence of United States or Canadian citizenship will be required of all participants. Only passengers on authorized buses will be permitted to enter the plant. Group luncheon will be served at noon.

Aerial view of the Lukens Steel Company, a pioneer steel producer of quality products.

AN INVITATION to STEEL MILL OPERATORS and ENGINEERS

It is with the greatest of pleasure that I extend to all steel mill operators and engineers a cordial invitation to meet with the members of the Association of Iron and Steel Engineers at the Annual Spring Conference in Philadelphia. The Spring Conference is being held under the auspices of the AISE Rolling Mill Committee. However, this year an innovation is being made in that parallel technical sessions are scheduled, thus broadening the scope of the program to include papers of general interest to all steel mill men, as well as to rolling mill operators.

A highlight of the 1947 Spring Conference will be the inspection trip through Lukens Steel Company, a leader in the production of quality products and specialties.

We know that your participation in this program will give you new ideas which can be applied to your work, and which will result in greater economy of operations, thus enabling you to meet the demands of postwar production.

L. R. MILBURN

President, AISE

Automatic Welding
IN STEEL PLANT MAINTENANCE

H. E. HOLMAN

By H. E. HOLMAN

JONES AND LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946

. . . . automatic welding machines have given outstanding economies in steel mill maintenance, particularly in reclaiming rotating parts . . . .

▲ THE position which maintenance welding has come to occupy as a fundamental necessity to steel mill operation during the recent years of maximum production and rapid deterioration of equipment is unquestionably one of prominence and importance. The problem of maintaining a steel plant during the war years became increasingly more difficult than it had been in the two preceding decades and, as the conflict progressed with its accompanying economy, skilled and semi-skilled welders were scarce because higher wages and supposedly better working conditions lured many dependable employees to other areas and fields of endeavor. Of necessity, our working force was supplemented by female employees and teen age boys, many of whom developed into capable craftsmen, but their training and the broadening of assignments required time. Almost simultaneously, many repair and spare parts became difficult to obtain and rationing and priorities were common to everyone. As a service department, we could not maintain the repair schedule required by our operating departments in salvaging and maintaining spare parts by manual welding, so we purchased automatic welding equipment as one of the processes which we had reason to believe would assure us greater speed, better quality and be applicable to those mechanical parts which required considerable time to weld manually, but a minimum of time in handling and positioning.

In the subsequent paper, I shall attempt to present some of the problems which should be considered prior to installation of this process and which we encountered at Jones & Laughlin, Pittsburgh Works, in reclaiming and salvaging worn parts; a few of the applications and results; and a brief summary of the advantages of this type of welding. For purposes of clarification, it is not my intention to point out the merits of this application in fabrication but only the rebuilding of worn steel castings and forgings of cylindrical shapes which must rotate during the welding procedure.

The two automatic welding units we use are essentially the same as those used in fabricating shops,

Figure 1 — The method of stacking welding wire shown here enables easy handling by overhead cranes.

Figure 2 — A journal for a blooming mill table roll is here being built up in an automatic welding machine.

except perhaps for high frequency starting apparatus, but the demands have been so great on rebuilding that progress in the fabricating field has been somewhat neglected.

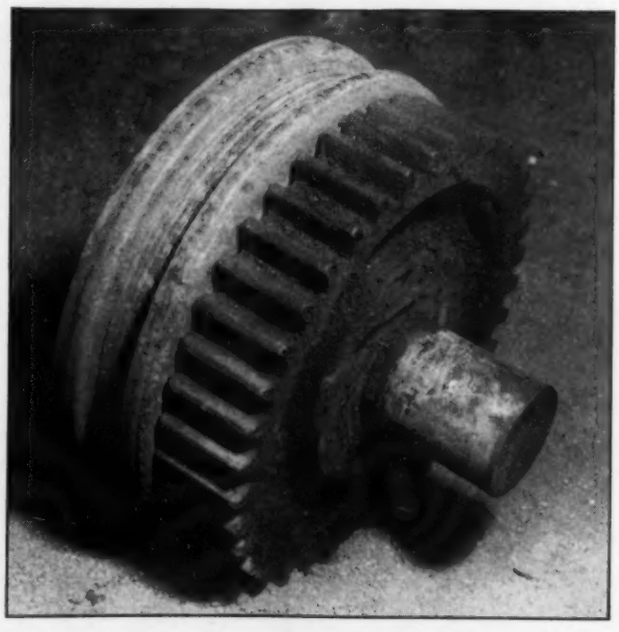
Automatic welding, as referred to here, is submerged arc welding and means the deposition of a filler rod, usually in the form of a coil of wire, to a base metal by electrical and mechanical means. Simply stated, the process results when an electric current is passed from the electrode to the work being welded, during which time, the wire is fed by small rolls which are part of the automatic head. The arc is submerged under a granulated flux which is placed on the base metal and around the wire by a hopper and tube assembly that is also standard equipment. The deposited metal dilutes with the base metal in a ratio dependent on the polarity and composition of the two metals. As the welding process begins, the flux melts, forms a liquid protective layer to eliminate atmospheric penetration, acts as a cleanser absorbing any contaminations in the fused metal and, depending on the flux composition, it may add to the metallurgical characteristics of the weld. By virtue of this total submergence, the arc is stabilized and prevents weld spatter, thus eliminating cleaning time and improving the quality and appearance of the weld deposit. Fixed shoes which ride on the base metal provide a flux dam to keep adequate flux over the arc. In a matter of seconds, as the weld moves away from the arc, the excess flux particles fall off and the fused flux or slag detaches itself, or, can be easily removed, either manually or by a fixed chipping hammer installation, and then stored for reclaiming. One type of welding head may require a steel wool starting fuse, while another may start the arc and automatically retract the electrode when the arc has been established.

Assuming that the readers are interested in this type of salvage and development, a few prerequisites warrant consideration. The primary essentials are a power supply from either a-c or d-c welding machines and an automatic welding head which performs the functions of depositing the fluxing agent, feeding the wire and transmitting current. Amperage requirements may range from 300 amperes for small diameter wire and work to 1200 amperes for large diameter wire and work with 20 to 40 volts across the arc. An ample welding machine power supply should be provided but not necessarily confined to this operation. In the majority of our applications, we found that welding was done between 600 and 900 amperes while using $\frac{3}{16}$ in. diameter and $\frac{1}{4}$ in. diameter wire. We have five 400 amperes, d-c motor-generator machines wired for polarization to be used on each head, and when amperage requirements are low, the machines not needed for auto matic welding may be used on manual welding jobs.

Some method must be provided to rotate the piece to be welded such as an engine lathe, a positioner with a rotating table, or turning rolls. Our early adventure in this field was quite inauspicous in that we possessed no rotating mechanism for the first group of crane wheels sent to us for rebuilding. We performed the job by tack welding an 18 in. pipe to the flange of the wheel, supported the wheel and pipe by the wheel pin on two brass bushings and rotated it with a plate burning machine which enabled us to travel at variable speeds. This illustrates that some improvising can be done to establish the process. More permanent equipment in the form of a 36 in. engine lathe was acquired and the welding head was mounted on the screw driven carriage; however, this placed some limitations on the size work we could handle and excluded such work as strip mill flying shear drum journals, plungers with cross-heads exceeding 36 in. and strip mill back-up rolls. By fabricating a set of turning rolls powered with a variable speed motor through a gear reducer, these obstacles were overcome. In our experience a lathe capable of swinging 60 in. with a screw attachment, to permit mounting the head on the carriage and deposit an even sequence of peripheral beads, is most desirable. The rotating equipment should have change gears or variable speed motors to give the best results over a wide range of diameters.

Another item due consideration is loading and unloading facilities. Monorails frequently limit the size of the work and are not as flexible as overhead cranes in such matters as organizing incoming and finished work,

Figure 3 — Rebuilding crane wheels was one of the first applications in the automatic welding program.



wire and flux handling and general shop arrangement.

We found that when all new wire was weighed, labeled and stored in vertical stacks around core poles, storage space was minimized and added to the ease of periodic inventories. The value of this manner of storage is important also because of the various outside diameters of the wire coils. High alloy coils frequently are drawn in weights of 25 pounds while straight carbon coils may run from 60 pounds to 200 pounds. All wire used should be clean, and preferably clad to provide good electrical contact with the jaws of the welding head.

Provisions also must be made for flux storage. It should be stored in a dry area and handled so that the bags are not broken before the approximate time of consumption. If excessive flux dampness becomes a problem, it should be thoroughly dried before using.

In the welding process, a portion of the flux becomes molten over the arc while that remaining in a loose granular form is collected and reused. Some operators have a vacuum cleaner to reclaim the unfused excess flux, others use a shovel and screen at the point of operation to separate the fused flux from the excess granular flux. Fused flux generally removes easily, with minor metallic contamination and can be reclaimed by a crushing process. Care should be exercised in this operation to obtain the proper size, because very coarse grains tend to result in deep penetration and narrow weld beads. Generally speaking when reground flux is screened through a 12 mesh screen for use on amperages in the 300-1200 range, the results will be satisfactory. We performed several chemical tests on the weld deposits made with new flux, flux used once, and flux used many times, and found that the resulting analyses on low alloy deposits would not warrant the discarding of the fused material. We regrind the flux over and over and use new flux only on extremely important alloy jobs. The result of this is that instead of more than one pound of flux fused for each pound of metal deposited, we decrease the flux consumption, over a long period of time, to one pound of flux to several pounds of metal deposited which makes an appreciable reduction in the final cost figures.

Ample preheating, concurrent, and postheating facilities should be available for alloy work in the form of multiple flame heating heads and furnaces for stress relief.

We believe one of the most important selections to be made by supervisors are the operators. Those with mechanical inclinations who will be proud of production rate and the close tolerances they can hold to eliminate unnecessary machining can save any maintenance welding department the actual cost of the automatic welding installation in a comparatively short period of time. The quality of the weld deposit in this type of application is not influenced by the operator's personal qualifications to function with a certain standard of physical and mental coordination, as is generally true in manual welding, but rather on his ability to observe and make reasonably precise mechanical and electrical selections. By these I refer to voltage, amperage, speed of rotation, and the location of the welding head with relation to the vertical center of the work. After some experience,

Figure 4 — There is an appreciable difference in the width of deposit required for the vertical edging rolls of the various roughing stands of a hot strip mill.

each of the above can be predetermined with a high degree of accuracy.

As previously stated, our first efforts in this field were confined to reclaiming crane wheels with worn treads and flanges. We began by using a 0.15 per cent carbon, 1.75 per cent manganese wire which had excellent machining qualities but was too soft for general crane wheel usage. The next group of wheels were rebuilt with a 0.60-0.70 carbon, 1.00 manganese, 0.22 silicon wire which gave us a deposited analysis of 0.18 carbon, 1.55 manganese, 0.50 silicon and a Brinell hardness of 200 which was somewhat lower in hardness than the original wheel. This was followed with a wire that had 1.00 carbon, 0.50 manganese and 0.15 silicon which resulted in a deposited analysis of 0.42 carbon, 1.50 manganese, 0.45 silicon and a Brinell hardness averaging 240. This wire for the present, is the one we are using constantly on wheel reconditioning. It may also be important to note that this analysis is desirable when a shaft can be salvaged and then flame hardened. This is a practice we have carried out on many applications to prolong the life of a wearing surface and minimize replacement costs. In addition to the wheels, the 0.60-0.70 carbon and the 1.00 carbon wires are used on blooming mill table roll journals and bodies, blooming mill housing roller shafts, strip mill flying shear drum journals, shear plungers, intensifier plungers, scrap press plungers, ladle car wheels, soaking pit cover axles and wheels, mill spingles, and the interpass for hard surfacing deposits on such applications as billet mill twister rolls.

In many of the examples just cited, the cost of welding is greatly reduced and frequently absorbed by eliminating the cost of a fitter's time in removing and refitting the pin in a crane wheel, or the axles in pit cover and ladle car wheels. In all of these cases, the cost of welding labor, welding materials and machining labor seldom equals one half the cost of the new piece of equipment.

Some additional applications which have been considered profitable and illustrative of higher alloy weld deposits are strip mill vertical edging rolls, strip mill coiler rolls, and a strip mill back-up roll. The practice on vertical rolls, in past years, was to forge them from 0.45 carbon steel and place them in service at a 20 in. diameter. These rolls could be dressed from three to four times and then consigned to scrap because the minimum operating diameter had been reached. The majority of these rolls had to be removed and machined after 12 turns of operations, thus the total life after

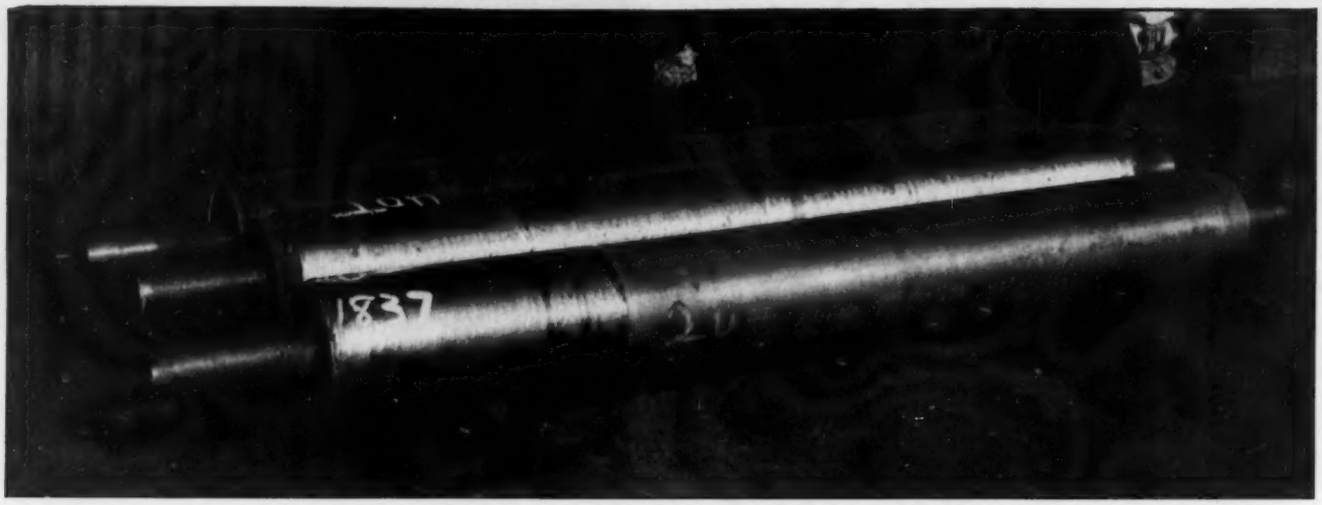


Figure 5 — The use of a strip mill coiler roll with a chrome-tungsten deposit eliminates the chilled iron roll with removable steel journals.

three to four machinings was from 36 to 48 turns. For the past two years, we have welded these rolls with an approximate SAE 6135 analysis core wire which has 0.35 carbon, 0.75 manganese, 0.25 silicon, 1.00 chrome and 0.15 vanadium with a deposited analysis of 0.18 carbon, 1.80 manganese, 0.60 silicon, 0.65 chrome and 0.10 vanadium. In this operation we believe a 500 F preheat and concurrent heat are essential for best welding results. Many of these rolls have been welded 10 to 12 times and are still far above the minimum working diameter because each weld deposit of approximately 20 pounds simply replaces the metal worn away by the rolling operation. The machining only requires the removal of excess weld metal stock and a $\frac{1}{32}$ in. cut across the face, so the cost of new forgings and fitting time has been practically eliminated. The average service of the welded roll, due to the wire analysis, has been increased to twenty turns which permits the rolls to be changed during the time assigned as the regular repair turn, so no mill delay is involved in this replacement. This application increases the life of vertical rolls several hundred per cent at a small fraction of the cost of a new roll each time they are needed.

Another item which has been a source of irritation to both maintenance and production departments is the strip mill coiler roll which is approximately 10 in. in diameter and 7 ft 10 in. long. In previous years, the practice was to use a cluster of chilled iron rolls with replaceable steel journals and these journals were the chief reason for mill delay and high maintenance costs. We were advised of a chrome-tungsten welding wire which could be furnished in limited supply and was supposed to possess definite work-hardening and abrasive resistant qualities at high temperature. The analysis on this wire was 0.33 carbon, 5.00 chrome, 1.40 tungsten and 0.95 silicon which resulted in a deposited analysis of 0.23 carbon, 1.18 manganese, 4.08 chrome, 1.15 tungsten and 0.92 silicon. Our procedure on this application is to first acquire a 0.45 carbon forging. The forging is rough turned to 9¼ in. diameter, placed in the welding lathe and preheated to 650 F. This temperature is maintained during the welding operation and it is desirable to deposit four or more layers of weld metal. This fourth layer, because of the analysis and with the air quench, will attain a 68-72 scleroscope hardness. Approximately 300 pounds of $\frac{7}{32}$ in. diameter wire is used to surface each roll.

The particular advantages of these welded rolls are that they can be rebuilt when minimum operating diameters are reached, they have rendered service equal to the iron rolls, they have not spalled, and there is no indication of any marking on the sheets.

Our greatest venture in this field to date has been the rebuilding of an 85,000 pound strip mill back-up roll which was 53 in. in diameter, when new, with a 7 ft 6 in. body length. The analysis was 0.90 per cent carbon, 0.78 manganese, 0.042 phosphorus, 0.030 sulphur, 0.88 chromium, 0.35 silicon and 0.40 molybdenum. The roll after some length of service has been machined to its minimum operating diameter of 48½ in. and had spalled. The roll was machined further to 46 in. to remove all the surface indentations and provide a comparatively smooth welding surface.

Considerable work was involved in fabricating the 10 ft 6 in. furnaces and designing the rotating mechanism required but we felt that the furnace was a necessary

Figure 6 — An elaborate furnace was required to preheat this 53 in. back-up roll during the welding operation.

Figure 7 — A total of 13,000 pounds of wire were used in building up this 53 in., 85,000 lb, strip mill back-up roll.

precaution and was the best method of obtaining and maintaining a 650 F temperature. The first layer of weld metal required 1000 pounds of a 0.08-0.12 carbon wire which was an inter-pass to dilute with the base metal and reduce the possibility of surface fracture. The remainder of the weld metal was on SAE 6150 analysis which is 0.48-0.55 carbon, 0.65-0.90 manganese, 0.040 maximum phosphorous, 0.040 maximum sulphur, 0.20-0.35 silicon, 0.80-1.10 chromium and 0.15 minimum vanadium. The roll was welded to a diameter of 52 in. which was great enough to allow machining back to 51½ in. outside diameter for mill operation. The welding procedure required 21 days to complete which included preheat and minor mechanical adjustments. A total of 13,000 pounds of wire was deposited, the rate of deposit varied roughly from 28 pounds per hour to 35 pounds per hour, the wire melted off at a rate of 90 inches per minute and straight polarity welding deposited approximately 30 per cent more metal than reverse polarity. We are not yet certain of the actual service this roll will give but we do have some convictions on the future development of this procedure in reducing maintenance costs.

In concluding this paper, we are of the opinion that there are some very definite advantages in automatic welding. Etch testing shows the weld deposits as clean, dense and deeply penetrated; higher speeds and higher currents are practical; electrode consumption is reduced because weld spatter and most stub end loss are eliminated; production increases as the result of the elimination of such elements as operator fatigue and the change of electrodes; finish machining time is reduced because of the close tolerances and the smoother working surface which result; and finally it would appear that, as time progresses, this application will become increasingly important in all steel plant maintenance and fabrication because each of the factors mentioned above contributes to improved costs and greater productivity which is the goal for which we all strive.

DISCUSSION

PRESENTED BY

R. P. PALMER, Welding Foreman, Wheeling Steel Corporation, Steubenville, Ohio

H. J. RALSTON, Maintenance Metallurgist, Homestead Works, Carnegie-Illinois Steel Corporation

R. P. Palmer: I think Mr. Holman should be complimented for having nerve enough to deposit 13,000 lb of weld metal on his first back-up roll. On the first roll we welded, we deposited approximately 400 lb of rod, and kept increasing gradually until we finally deposited 5000 lb. Our rolls, of course, are smaller, being 44 × 60 in.

One statement, Mr. Holman made, should be elaborated upon, regarding the selection of operators. This is probably the most important part of automatic welding. If your operators are assigned by a system of seniority, you will be handicapped. They should be selected by ability and a genuine desire to make a success of automatic welding. As an example, we welded a roll last month, just a routine job, building the roll from 41.750 in. to 44.250 in. We experienced considerable trouble with our supply of coke gas. It fluctuated, causing the temperature of the roll to drop several times during the welding operation. Eventually it was completed and placed in the furnace for further treatment, and again we had trouble with our supply of gas. When the roll finally was cooled off sufficiently, we went into the furnace to inspect it, and discovered a crack lengthwise the full length of the body, through the weld metal and into the base metal. On one end the crack was about 7½ in. deep, on the other end about 6 in. deep.

That operator and I were probably the most broken hearted people in the world at that particular time. He suggested we weld the broken roll and I agreed to try. We heated the roll again, removed it from the furnace and scarfed a "vee," removing metal to the bottom of the fracture. Since we could not rotate this roll, we could not keep heat on it during the welding operation. We heated the roll during the night in the furnace and placed it in the lathe each morning and welded as long as the temperature would permit at about 800 F. The roll was then returned to the furnace and heated until the following morning. The roll cleaned up a little oversize. It is in service at present and the diameter is 44 3/16 in., and has rolled almost 400,000 net tons. The success of a job of this sort depends upon the operator.

One suggestion on rolls that are down to discard size and have spalls in the body, is to remove the spalled section by cutting a ring around the entire roll to the width and depth of spalled area; weld this low place first, and then build up body.

Regarding tonnages on welded rolls, on the first roll we welded back in 1940, we increased the diameter 0.540 in. and rolled 430,224 net tons of steel. The original roll rolled 652 net tons per each 0.001 in. reduction. The welded roll rolled 795 net tons per 0.001 in. reduction, taking the figure from a roll now down to

discard size. The diameter was increased 0.680 and rolled 1,076,047 net tons. The original roll rolled 780 net tons per 0.001 in. reduction, and the welded roll rolled 1571 tons per 0.001 in. reduction.

There are two things quite necessary for successful automatic welding, especially on back-up rolls, that is a general master mechanic that is willing to let the welding department try new ideas and a hot strip superintendent that has much patience while you are trying them.

H. J. Ralston: Mr. Holman's paper is of particular interest to us because for the past several years, we too have been successfully applying this process to the rehabilitation of used mill equipment and, as the result of our experience, enthusiastically concur as to the practicability of the process and the several advantages of such an installation for steel plant maintenance.

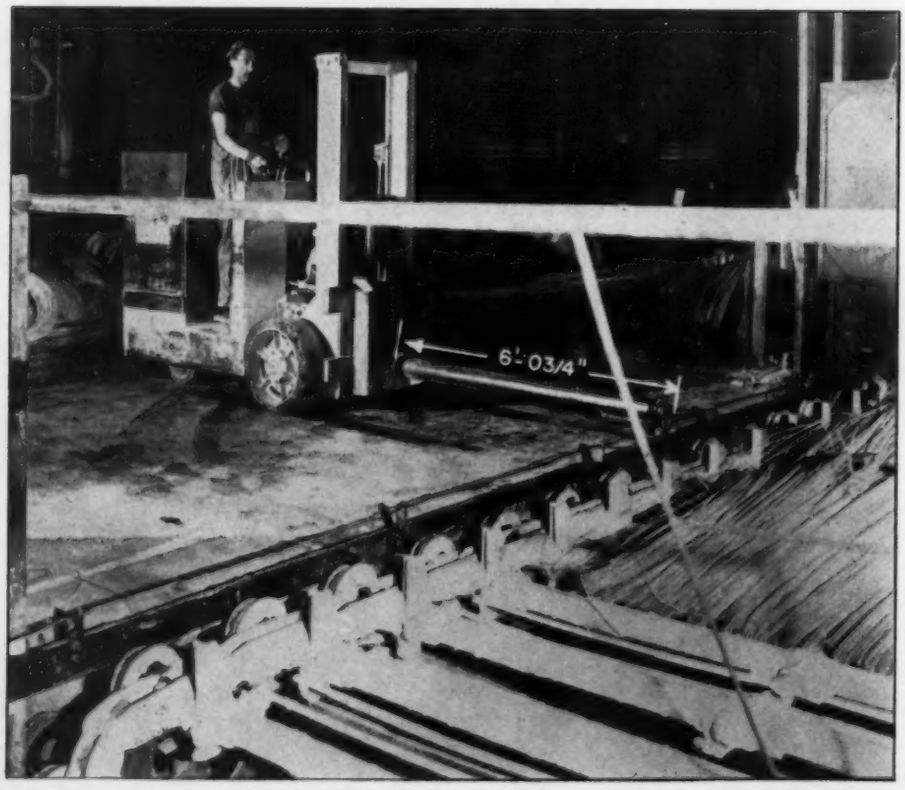
In connection with the successful application of this process, I believe that one point deserves additional emphasis; namely, an appreciation of the fact that the fused metal, once solidified, tends to contract in further cooling to room temperature, but that this contraction is entirely prevented by the immobility of the base metal in the temperature range between solidification and that of the base metal. Such a situation naturally produces a high degree of tension in the weld and, unless certain precautions are taken, may result in failure through cracking. The automatic nature of and the inherent characteristics of the process practically guarantee a physically and metallurgically sound, clean weld completely fused to all adjacent and underlying metal, so that only this fact need be reckoned with in a given application. Our experience has been that, in applying a low carbon wire with or without a small alloy addition to a moderate or low carbon item moderately stressed in service, no special precaution need be observed such as preheating or postheating. Generally speaking, however, as the alloy and carbon contents of the weld metal increase, the metal progressively loses its capacity to withstand this shrinkage stress, and rupture may occur unless proper preheating, post heating and equalized cooling are effected. Determination of the degree of preheating, etc. to reduce these stresses to an unobjectional minimum is largely a matter of experience.

In using reclaimed flux, we have had the occasional experience when welding relatively small diameter rounds that the molten slag could not be prevented from rolling off the work so that a successful weld was impossible. When this flux was replaced with new material, a normal weld was obtained. Our laboratory reported the following analyses of samples of new and once used flux:

	SiO_2	Mn	FeO	Fe_2O_3
New Flux	39.80	33.41	0.29	2.08
Once used flux	37.40	31.43	6.92	0.16

From this report it is apparent that the chemistry of the flux is appreciably altered by use, particularly the FeO content. This may account for an increase in fluidity and the attendant difficulty noted above. Since, in crushing, handling, and screening, we normally lose about twenty-five per cent of the material, we plan to set up a reclamation system incorporating continuous mixing of a definite percentage of new and used material. Material finer than 60 mesh is discarded as it interferes with the vacuum system by clogging the filter bags. This should produce a relatively uniform composition flux having the most desirable characteristics compatible with the particular percentage of reclamation established.

AMERICAN STEEL AND WIRE DEVELOPS TELESCOPIC RAM TRUCK



A telescopic ram truck and wire arrester gear have been designed and developed by the American Steel and Wire Company for use in the Trenton, New Jersey, plant. The telescopic ram can be extended to a length of 9 ft by engaging its hooked end in a length of steel rope attached to strong springs and placed along the edge of the loading platform. After picking up its load of loosely coiled wire, both ram and load are shortened, by butting the ram against a well anchored steel bumper, to a length of 6 ft, giving added maneuverability through the shop.

THE CORRUGATING OF SHEET METAL

. . . . because of improvements in dies and in the corrugating machines themselves, any sheet with any kind of a contour which will make a practical roof can be made on present-day machines . . . .

By J. E. KIEFER

Chief Engineer

Streine Tool and Manufacturing Company

New Bremen, Ohio

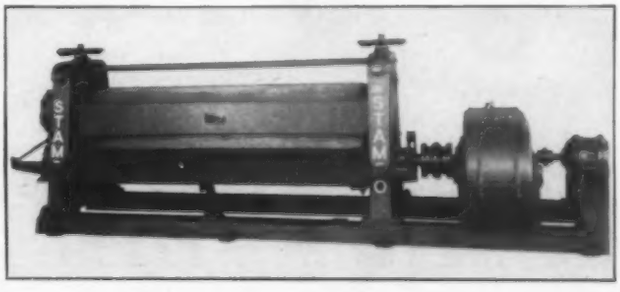
▲ SINCE the beginning of time, improvements have been made in the mode of living. The methods used to manufacture the different articles have been improved to make a better product or save the hard labor that had to be exerted through primitive methods employed. This same development took place in the corrugating of sheets. The first method was to place the sheet metal to be corrugated on a form or die and the corrugation or stiffener was hammered into the sheet manually with a hammer. Later these dies were placed under a press and each single corrugation was pressed into the sheet. In many cases the dies were made of hard wood. This method was used for a number of years, but it proved to be slow and costly. In some instances, however, it is still being used.

Later, the two roll corrugator was developed with cored cast rolls, the corrugations being machined in the roll proper, cast tooth gears were employed, and the machine proper was driven by belt from a line shaft. This development came in 1885. The product produced on this machine was very inaccurate due to deflection in the rolls, inaccurate machining of the dies, cast tooth gears and many other items. In 1898, O. O. Poorman conceived the idea to machine the rolls into hexagon shapes and to place dies which were bolted on the machined surfaces. This was called the interchangeable die type corrugator. At this time the cast tooth gears were replaced by cut tooth gears; the line shaft drive was replaced by a series of gears and driven by a motor and pinion. It was quite an improvement over the old type machine, but still the deflection and inaccuracies of machining the dies caused a poor product to be formed on this type of machine. For many years this was the approved method of making corrugated sheets.

As time went on, a new roofing was introduced to the trade, commonly known as "V"-crimp. Originally, this product was made on a press at a very high cost and low production, but was highly in demand. We were asked if it would not be possible to roll this product on a corrugator. Although, reluctant at first to try, considerable experiments showed that it was feasible, and around 1927 the first successful "V"-crimp was rolled on our corrugator. The product was not too accurate, but was acceptable to the trade.

Then came an era that caused the steel mills and manufacturers of corrugating machines considerable trouble. Each manufacturer handling roofing or siding wanted a product that had to be correct for covering width in both corrugated sheets and "V-"crimp sheets. Each piece had to be identical in all respects, especially "V"-crimp. This occurred during the depression period, and every salesman came in with a new idea as to how a roof or siding should be made. Steel mills were also experimenting with the galvanized coating, with each

Figure 1 — The corrugator shown is a standard No. 6 machine and can corrugate 12 ft sheets of 12 gauge and lighter.



Presented before AISE Annual Convention, Cleveland, Ohio, October 1, 1946

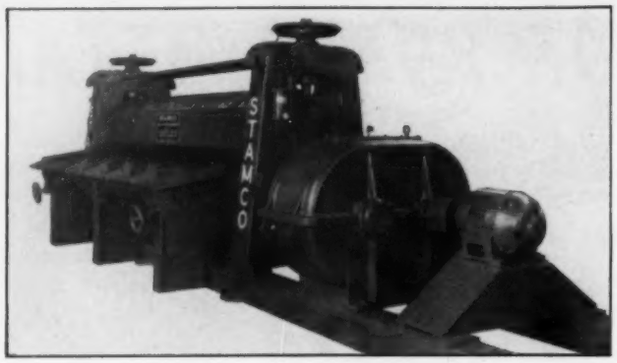


Figure 2 — A chain table feeds the high speed No. 6 machine shown.

trying to make a better product cheaper. They also were changing from the old type sheet which had been rolled in pack, to the new type of strip sheet.

This problem was given to all types of manufacturers to overcome. Some gave it to the continuous rolling machine manufacturers, others stayed with the manufacturers who had been building corrugators for years. Our company was asked to build a machine that would corrugate a sheet perfectly without breaking the coating. The cored cast rolls were eliminated and a hammer forged steel roll was substituted. These rolls were machined very accurately, and the dies were machined as perfectly as it was humanly possible. Back-up gears were placed on the adjustable rolls to take care of backlash in the gears and thus prevent any slippage between the rolls when they were adjusted properly.

After many experiments we were able to produce a machine and dies to meet all the requirements of the mills. While we were experimenting, some roll forming machines were built for corrugating sheet iron, and to a certain extent, made a successful rolled sheet. They never quite eliminated the cracking or breaking of the coatings. At times we thought we might be going in the wrong direction, so we decided to build a rolling machine with a series of shafts and rollers, but continued experimenting with the corrugator. After two years of trying to build a roll forming machine that would form the sheet perfectly without breaking the coating, we abandoned the idea as not workable. We obtained fine formed sheets, but the coating caused no end of trouble. We also learned from the steel mills that they were having the same trouble with roll forming machines.

By this time, the old rough corrugator had become a machine tool. The machine had been speeded up considerably, the rolls and dies machined to their proper dimensions, and a new special alloy mixture had been poured into the die casting to eliminate the adhering or breaking of the coating. All gearing was enclosed and run in a bath of oil. A perfect sheet was rolled whether it was 1¼ in. or 5 "V"-crimp with dry lap.

Just before the period when all this experimenting went on, we were asked to build a heavy corrugator for culvert stock which could corrugate anything from 16 to 8 gauge. We made up a machine with a continuous feed with three sets of dies. This machine corrugated the sheets so fast that the old method of using a press has almost been eliminated. The same type of accuracy is employed in this large No. 8 corrugator that is put in the No. 6, and the same results in accuracy are being enjoyed by the users of this machine.

In the manufacturing of corrugators and dies to produce a product acceptable to the trade, we find the corrugator has to be built with machine tool accuracy. Strange as it may seem, regardless of how heavy the machine is built, and how accurate it is machined, it is still very sensitive and requires very accurate setting before corrugating. There are three distinct types of corrugators, namely: the standard No. 6, the high speed No. 6, and the standard No. 8.

The standard No. 6 machine has six-sided rolls accommodating two sets of dies and is fed by an oscillating table operating at a speed of 4 to 12 rpm with a capacity of 12 gauge and lighter sheets 12 ft long, as shown in Figure 1.

The high speed No. 6 machine has six-sided rolls accommodating two sets of dies and is fed by a chain table operating at a speed of 8 to 24 rpm with a capacity of 12 gauge and lighter sheets, 12 ft long, as shown in Figure 2.

The standard No. 8 machine has nine-sided rolls accommodating three sets of dies and is fed by a chain table operating at a speed of 4 to 12 rpm with a capacity of 8 gauge and lighter sheets 14 ft long, as shown in Figure 3.

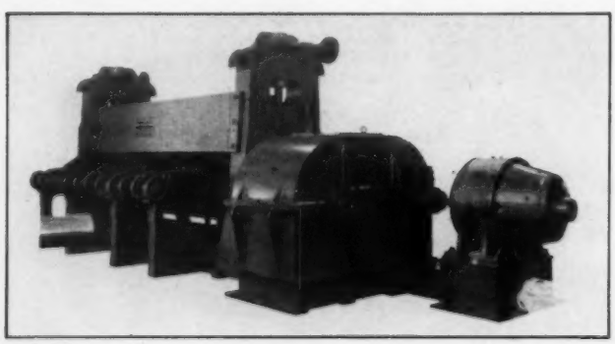
The most essential parts in the fabrication of corrugated sheets are the dies which produce them. In this discussion we shall classify these dies under two different headings, namely, dies for corrugated roofing and siding, and dies for "V"-crimp and channel drain roofing.

In analyzing the first classification, we find the following dies:

1. 1¼ in.
2. 2½ in. light.
3. 2½ in. medium.
4. 2½ in. heavy or culvert.
5. 3 in. British or export.
6. 3 in. American.
7. 5 in.

All of these dies can be furnished on both the No. 6 machines and also the No. 8 machine, and will produce exactly the same product, although the number of the dies is different for the No. 6 and the No. 8.

Figure 3 — The standard No. 8 machine has three sets of dies instead of two sets used in the machines of Figures 1 and 2.



In analyzing the second classification we find the following dies:

1. 2 "V"-crimp.
2. 3 "V"-crimp.
3. 4 "V"-crimp.
4. 5 "V"-crimp.
5. 6 "V"-crimp.
6. Channel drain.

These dies are made for the No. 6 machine only.

We shall first discuss the dies for corrugating roofing and their product.

The 1¼ in. is termed as No. 1.255 die on both our No. 6 and No. 8 machines and is for corrugating 26 to 29 gauge sheets. Some 22 and 24 gauge have been rolled. There are two types of 1¼ in. sheets, one known as roofing, the other as siding, as shown on Figure 4.

The roofing sheet has one corrugation up and one corrugation down, the corrugations being $\frac{15}{64}$ in. deep, with a covering width of 24 in. over 19 corrugations and an overall width of sheet 25½ in. made from a 28 in. wide sheet.

The siding sheet has both end corrugations down, the corrugation being ¼ in. deep, with a covering width of 24 in. over 19 corrugations and an overall width of sheet 25 in. made from a 28 in. wide sheet. There are some 1¼ in. corrugated $\frac{5}{16}$ in. deep and are known as eastern, but very little of the product is produced.

The 2½ in. light die is termed as No. 2.65 on the No. 6 machines and No. 2.66 on the No. 8 machine and is for corrugating 26 to 29 gauge sheets.

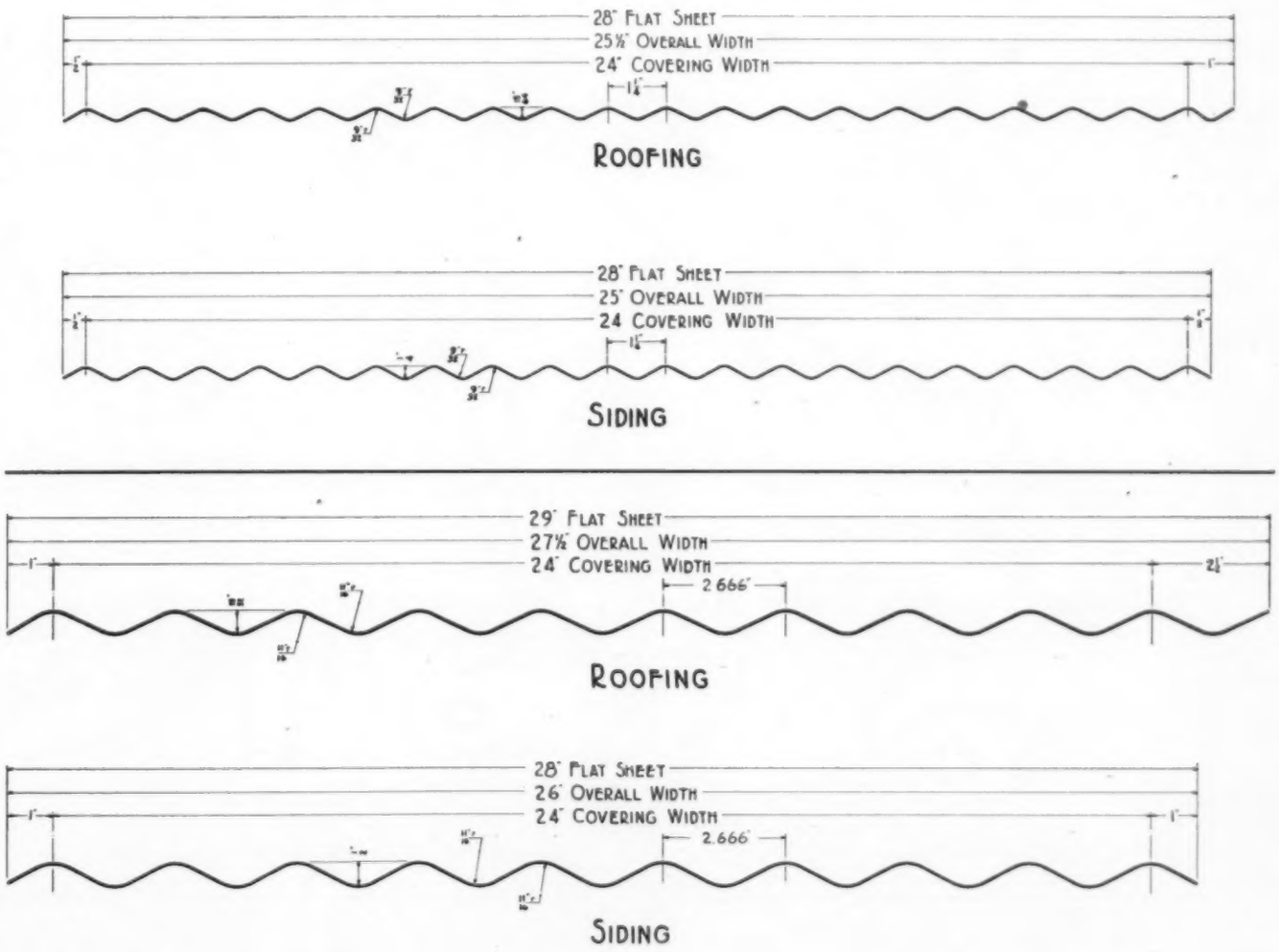
The 2½ in. medium roofing die is termed as No. 2.69 on the No. 6 machine and No. 2.71 on the No. 8 machine, and is for corrugating 20 to 24 gauge sheets. There are also two types 2½ in. sheets, one known as roofing and the other as siding, shown on Figure 4.

The roofing sheet has one corrugation up and one down, the corrugations being $\frac{13}{32}$ in. deep with a covering width of 24 in. over 9 corrugations and an overall width of sheet of 27½ in. made from a 29 in. wide sheet.

The siding sheet has both end corrugations down, the corrugations being ½ in. deep, with a covering width of 24 in. over 9 corrugations and an overall width of sheet of 26 in. made from a 28 in. wide sheet.

The 2½ in. heavy or culvert die is termed the No. 2.73 on the No. 6 machines and No. 2.768 on the No. 8 machine and is for corrugating 12 to 16 gauge on the

Figure 4 — Roofing and siding corrugations are not the same as shown in this sketch giving details of 1¼ and 2½ in. corrugations.



No. 6, and 8 to 16 gauge on the No. 8 machine. The standard depth of corrugation is ½ in. with a covering width of 24 in. over 9 corrugations, overall width, 25½ in. made from a 27⅝ in. wide sheet. This is termed as standard but 26 in. overall width may be obtained from a 28 in. wide sheet. The overall width depends upon the amount of lap desired. In the product from a 27⅝ in. wide sheet, gripper bars are used to turn the edges up at a smaller radius, thus obtaining a tighter lock at the seam of the culvert.

The 3 in. British or export and the 3 in. American die are for corrugating 24 to 32 gauge sheets. The number of these dies varies in accordance with the gauge as follows:

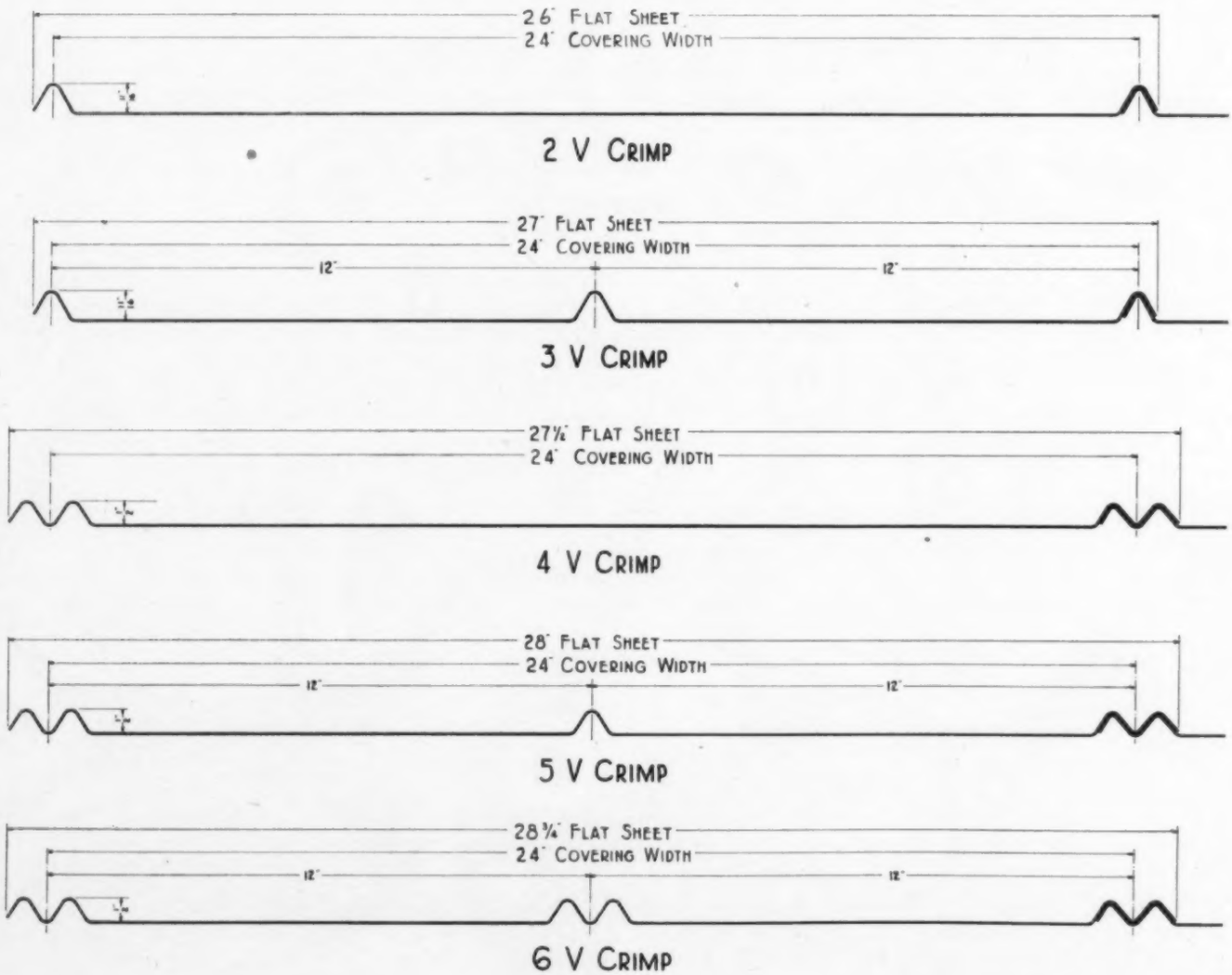
1. For 31 to 32 gauge, the die number is 2.812 on the No. 6 machines.
2. For 28, 29 and 30 gauge the die number is 2.875 on the No. 6 machines.
3. For 24, 26 and 27 gauge the die number is 2.9375 on the No. 6 machines.
4. For 24 to 26 gauge the die number is 2.990 on the No. 8 machine.

The depth of corrugation on the British varies from ⅝ in. to ¾ in., while on the American the depth is 9/16 in. The overall width varies on the British depending on the number of corrugations and lap desired. The sheets range from 31½ in. overall from a 36 in. wide sheet to 25½ in. overall from a 29 in. wide sheet. The covering width in all cases is 24 in. over 8 corrugations.

The No. 5 die is termed No. 5.137 on the No. 6 machine and No. 5.169 on the No. 8 machine and is for corrugating 12 to 16 gauge sheets. The depth of corrugations varies from ⅞ to 1¼ in. The overall width varies depending on the number of corrugations and lap desired. The sheets range from 31½ in. overall from a 36 in. wide sheet, to 28 in. overall from a 31 in. wide sheet.

On a standard corrugated sheet, it is difficult to maintain the covering width and also the overall width in the various gauges. For example on a standard 2½ in. corrugated sheet, you may have the correct covering width of 24 in., but the overall width may be short or long. This difficulty may be overcome by changing the

Figure 5 — "V"-crimp sheets may have from 2 to 6 crimps in each panel.



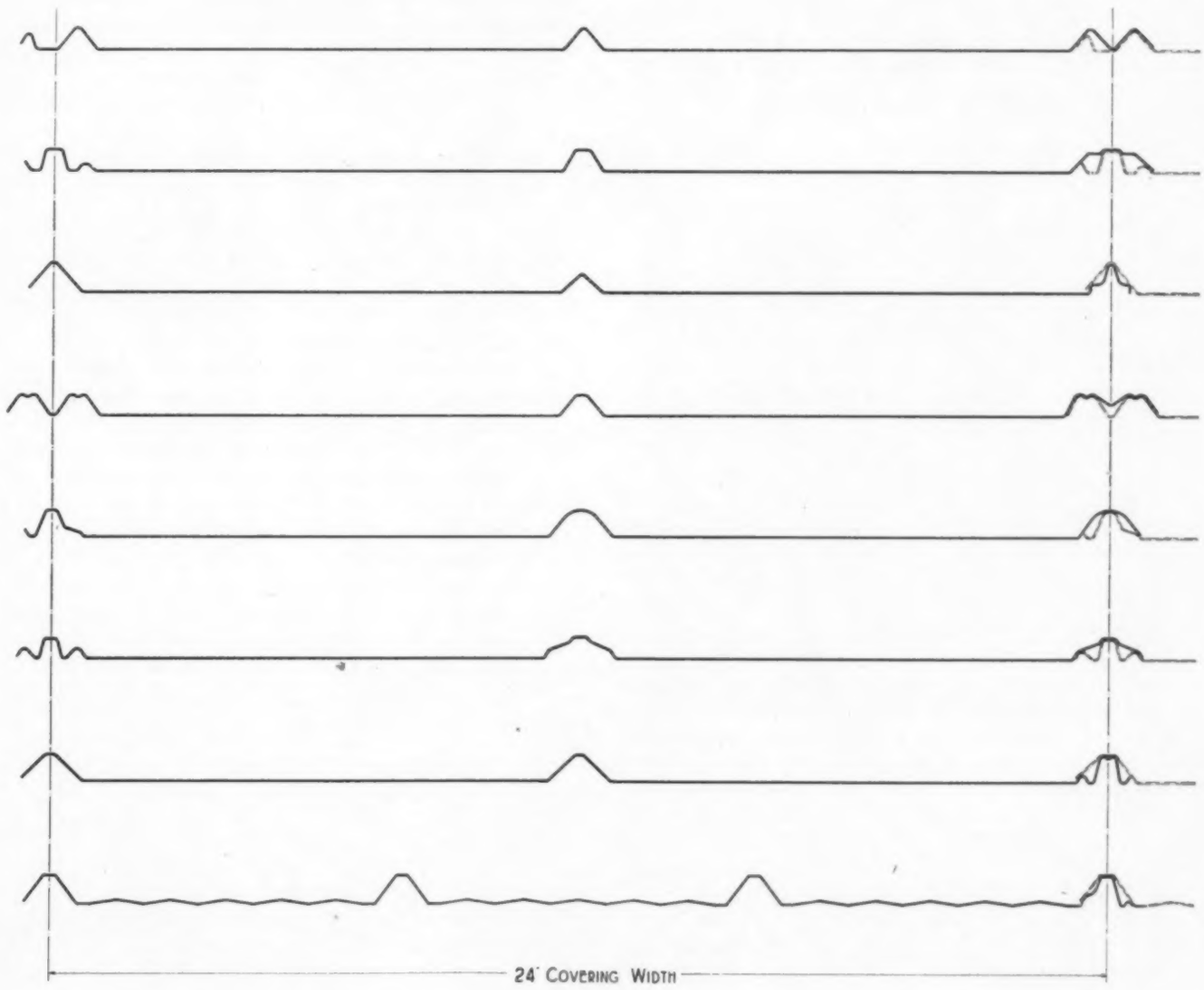
radii of the corrugations on the dies. If the sheet is too narrow in width, the radii is reduced enough to compensate for this shortage. If the sheet is too wide, the radii is increased to take up this additional metal. This can be done without changing the covering width of the sheet.

As already stated, in the former years when the corrugator was first originated, it was designed to corrugate hand rolled sheets. The rolls were made of cast iron and cored out in the center. Likewise, the die plates were cored. As the heavier gauge sheets were corrugated, the rolls and dies naturally deflected and a product was obtained which was narrow on the ends and wide in the center, but was at that time acceptable to the trade. At the time strip steel was introduced, it necessitated going to solid steel forged rolls and solid die plates. Our experience has taught us that there is quite a difference between the hand rolled sheets, and strip steel when corrugating; insofar as the strip steel is much harder, it has more spring in it, and the sheets from one mill to the other vary. The sheet which was narrow on the ends and wide in the center, was no longer acceptable to the trade. All of these factors helped to bring about the heavier rolls and more rigidity.

Sheets having saw tooth corrugations are no longer acceptable. To overcome this we have added back-lash gears to hold the bottom corrugation dead in line with the top corrugation. The accuracy with which the rolls and dies are planed is of the utmost importance.

To get a perfect rolled sheet, one that is uniform and the correct covering width, you should have a set of dies for each gauge. This would be entirely too expensive, so the dies are made to take care of several gauges and to corrugate a perfect sheet half-way between these gauges. For example, on the No. 6 corrugator, the 2½ in. medium dies for corrugating 20 to 24 gauge are made to corrugate a 22 gauge sheet perfectly. When rolling 20 gauge the sheet will be short in covering width, while in rolling 24 gauge the sheet will become long. The variation, however, will not exceed 1/16 in.

Figure 6 — Channel drain contours have rather varied shapes.



either way. It is best to have the sheet come short because, after laying for some time, it elongates.

We recommend the No. 6 high speed corrugator with the chain feed table for corrugating roofing gauges and the standard No. 6 corrugator with the oscillating table and also the standard No. 8 corrugator for heavier gauges.

Production obtained on the corrugator varies considerably depending on the gauge and the speed with which the operator works. From one to five sheets per pass may be corrugated.

The dies for the corrugating of "V"-crimp roofing, shown in Figure 5 will next be discussed.

The 2 "V"-crimp has a covering width of 24 in. center to center of outside V's and is made from a 26 in. wide sheet. The heights of the V's are 11/16 in. There are some 2 "V" made with the V's 3/4 in. high, although very little of this is done.

The 3 "V"-crimp has a covering width of 24 in. center to center of outside of V's. The center V is 12 in. from either side and the whole sheet is made from a 27 in. wide sheet. The heights of the V's are 11/16 in. There is a very little 3 "V" made with the V's 3/4 in. high.

The 4 "V"-crimp has a covering width of 24 in. center to center of outside V's and is made from a 27 1/2 in. wide sheet. The heights of the V's are 1/2 in., but in reality they are 17/32 in.

The 5 "V"-crimp has a covering width of 24 in. center to center of outside V's. The center V is 12 in. from either side and is made from a 28 in. wide sheet. The heights of the V's are nominally 1/2 in., and in reality they are 17/32 in.

The 6 "V"-crimp has a covering width of 24 in. center to center of outside V's. The center two V's are 12 in. from either side and are made from a 28 3/4 in. wide sheet. The heights of the V's are nominally 1/2 in., and in reality they are 17/32 in.

There are many different types of channel drain roofing and up to the present time, we have made dies to produce thirty-six different products of both 3 "V" and 5 "V," a few of which are illustrated in Figure 6. The covering width is 24 in. center to center of outside V's. The center V is 12 in. from either side. The width of the flat sheet used ranges from 26 1/2 in. to 30 in. The heights of the V's vary from 1/2 to 3/4 in.

On both the "V"-crimp and channel drain dies we have furnished two distinct types of dry lap, namely the 2 V and the 3 V, and in a number of cases for various customers have furnished buttons and darts.

There are quite a few items which enter into making a set of dies for producing a channel drain product. One of these is the manner in which the product is applied to the roof, i.e., whether the roof is laid right to left or left to right. This determines the location of the channel drain insert in the dies and also the location of the dry lap, if any, on the sheet. The channel drain insert may be rolled as the No. 1 or as the No. 3 die.

With reference to this point, there are many cases where it is impossible to roll the channel drain insert as the No. 1 die and must be rolled on the No. 3 and vice versa, due to the contour of the drain.

If the shape of the drain is such that there are sharp corners or the angles are too steep, the dies have a tendency to break the coating on the sheet. The breaking of coating on the sheet, especially on the seal of quality, has been overcome by doing two things. First, the pitch line of the insert has been dropped, thus bringing the top of the male insert closer to the normal pitch line of the roll itself, while raising the bottom of the female insert, bringing it closer to the normal pitch line of the rolls. In other words, the male and female inserts travel at a more uniform speed, thus causing less rubbing action during the corrugating. Second, the inserts are very highly polished so that there is less chance for the coating on the sheet to adhere to the insert.

We recommend that channel drain sheets be run on the No. 6 highspeed corrugator with the chain feed table, first because it is much faster; second, it has more accurate feeding; and third, with the adjustable table and dogs, it insures the sheet being fed into the rolls at the correct time so that there is the right amount of metal to form the V.

Considerable trouble was incurred when the various "V"-crimp and channel drain dies were first made. The "V"-crimp inserts were bolted solid into the die plates thus preventing them from being moved after machining. Due to the contour of the sheet, the variation in metal from one mill to the other, the gauge of the material, etc., we could never get the product to come out exactly 24 in. on the covering width. To remedy this condition, the inserts in the die plates were made adjustable so that the correct center distance from one V to the other could be maintained. Again I would like to stress that it is the accuracy with which these inserts and dies are planed that is largely responsible for the product produced.

Machining a set of channel drain dies necessitates much time and work. There is a definite routine which must be followed:

First, the contour must be determined. The general contour is determined by the customer, but after we receive it, we must lay it out four times the size to determine the various radii and to be sure it does not take any more metal than is allowed.

Second, our templates are laid out and samples rolled to ensure metal clearance and that the corners do not break the coating. In testing the templates the same metal is used that will be used on the finished product.

Third is to determine whether the channel drain will be rolled as the No. 1 or No. 3 die.

Fourth, the sample contours are sent to the customer for their approval.

Fifth, after the approval of the samples, the full length dies are made and tested. In a good many cases the inserts have to be reworked so that they will produce a product that corresponds to the sample.

Sixth, the finished product is then sent to the customer for their final approval after which we may deliver the dies.

Within the past year we have increased the speed of our No. 6 high speed corrugator from 5 to 15 rpm, to 8 to 24 rpm. The reason for having a variable speed is to be able to slow the machine down when rolling heavy gauges and difficult channel drain contours, and to speed it up on the light gauges and less difficult drains.

The production of channel drain on the No. 6 high speed corrugator is one sheet per pass. If the drain is

not a difficult contour and rolls easily, and a tight coat sheet is used, two sheets per pass may be rolled, and this can also be done on "V"-crimp. Any more than this results in the bottom sheet not having the same contour as the top.

On these corrugators any sheet with any kind of a contour that will make a practical roof can be made. The greatest improvement in the corrugators in the past years has been made in the dies proper.

DISCUSSION

PRESENTED BY

C. W. BECK, Assistant General Superintendent, The American Rolling Mill Company, Middletown, Ohio

J. E. KIEFER, Chief Engineer, The Streine Tool and Manufacturing Company, New Bremen, Ohio

J. L. TATMAN, Assistant to General Manager, Wheeling Steel Corporation, Steubenville, Ohio

NELSON COOK, General Superintendent of Galvanizing Operations, Wheeling Steel Corporation, Wheeling, West Virginia

C. W. Beck: It is very interesting to see the emphasis that has been placed on the dies and the die accuracy. I think this has been a very substantial improvement. The author referred to the rolling through rollers of corrugated sheets. Having tried that some years ago, we are just wondering if, with the continuous methods of galvanizing that are here, we are not ready to consider that problem again?

J. E. Kiefer: As was stated in the paper, we tried a roll forming machine, and found out that, at least with present methods, we were able to corrugate faster and produce a better product on our corrugators than were made on the roll forming machines. Roll forming may be improved later on, but at present we think we have the best method.

C. W. Beck: I noticed your main objection was the coating. Was that the only objection to rolling at that time? Some of those things are being overcome at the present time.

J. E. Kiefer: Production on the roll forming machine was another objection. We found that with most all types of channel drains we were unable to operate at a greater speed than 125 feet per minute which would give you approximately ten 12-foot sheets per minute. Our roll corrugator operating at 24 rpm, would produce twenty-four 12-foot sheets per minute. This is just as good a product and is produced at less expense.

Operation and maintenance was another objection. Due to the variation in the hardness of sheets and the sheet itself, we found that when the rolls were set properly for one sheet, they may not be set properly for the second; the result was either a variation in contour or the cobbling of the sheet, thus causing a considerable amount of maintenance and loss of production. Changing rolls for the different contour of sheets is both expensive from the standpoint of new rolls and the set-up time is in excess.

J. L. Tatman: What is the hardness and the composition of the metal that is used in the manufacture of the dies?

J. E. Kiefer: The type of material we are putting in our dies is a close grain structure of our own manufacture, produced in our own foundry. It is of such composition that the coating will not adhere to the dies.

J. L. Tatman: In making "V"-crimp roofing, runningtwo sheets at a time, peeling of the coating is encountered. Why is it always so pronounced on the bottom side of the bottom sheet?

J. E. Kiefer: On the outside of the V's the coating has a chance to elongate or stretch, whereas with the under side of the V's it is put into compression which causes flaking of the coating.

Nelson Cook: Mr. Kiefer has written a very good paper which covers the development of corrugated and other formed roofing. We are in agreement with everything he says, and that is to be more or less expected, since most of the development referred to was made with our company and represents practices which are not yet universally adopted by our competitors.

LARGEST ROUND FORGING MOLD USES 180 TONS OF MOLTEN STEEL

John Hague dispatches world's largest round forging mold, just completed by Clairton, Pennsylvania, works of Carnegie-Illinois Steel Corporation, to Clairton's sister plant at Homestead, Pennsylvania. This 180-ton silica-iron mold, three feet wider than the largest 24-wheel well car, required special routing for the ten mile trip down the Monongahela to Homestead. The giant form will use all the molten steel Homestead's largest open hearth furnace can produce in 12 hours to shape a single 250-ton generator or cyclotron forging.

Mercury Arc Frequency Changing

▲ IT is interesting to observe that the commercial development of mercury arc converters and induction heating of metals has taken place largely within the last twenty-five years, and yet it is only within the last three years that mercury arc converters have been applied as frequency changers for induction heating.

Steel tank mercury arc converters were first installed extensively in the United States in the late 1920's for rectifying alternating current power into direct current

. . . . induction heating with mercury arc frequency changing equipment can provide many advantages . . . . a careful engineering analysis is required, however, to determine economics and suitability . . . .

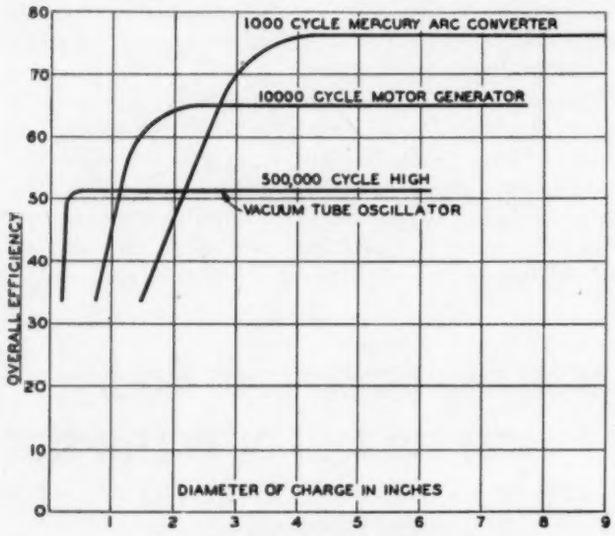


Figure 1 — Better efficiencies are obtained in induction heating for the larger charges with the lower frequencies.

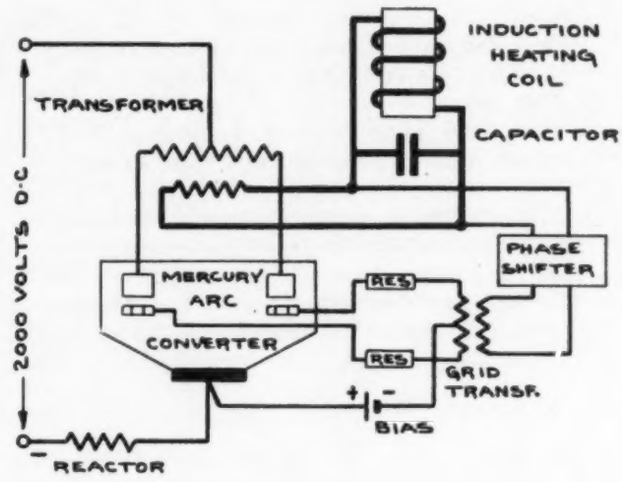


Figure 2 — Elementary inverter circuit.

power for electric traction systems. A few years later, rectifiers were adopted for electrochemical plants, and more recently they have been widely used for converting a-c into d-c power for steel mills, mines, and industrial plants. The extensive use of mercury arc rectifiers in recent years can be appreciated when it is realized that about 10 per cent of the electrical power generated in the United States can be converted into direct current by means of them.

Mercury arc converters, today, have become a much more useful device than they were originally, because, by means of grid control, it is possible to employ them to convert a-c power of one frequency into a-c power of another frequency. Installations of several thousand kilowatts capacity have been made for interconnecting 25 cycle and 60 cycle power systems in steel mills. Also, installations for converting 3-phase, 60-cycle power into single-phase power of a frequency of about 1000 cycles per second have been made for induction heating of metals.

For melting many metals in induction furnaces having capacities from about 300 lb up to several tons, a frequency of the order of 1000 cycles has been found to be of greatest value from an operation and an efficiency standpoint. For heating metals for upsetting or forging operations, frequencies between 1000 cycles and 3000 cycles are most widely used, and for brazing of metals, hardening of steel and other special applications, frequencies of the order of 10,000 cycles are employed, as well as frequencies up to several hundred kilocycles.

Motor-generators have been used to convert 3-phase, 25 or 60-cycle power into single-phase power of the order of 1000 cycles to 10,000 cycles frequency, and spark-gap converters and high vacuum tube oscillators have found extensive applications in the induction heating field where higher frequencies are needed or are desirable. However, by far the largest kilowatt capacity of installed equipment for induction heating at present is represented by motor-generators supplying frequencies of the order of 1000 to 3000 cycles for induction melting and forging; and because it is within this range of frequencies that mercury arc converters can operate to best advantage, mercury arc frequency changing equipment has been applied so far only to forging and melting applications.

So much has been written on the history of the development and on the elementary principles of induction

Presented before AISE Philadelphia District Section Meeting, March 2, 1946.

Equipment for Induction Heating

By S. R. DURAND

Application Engineer

Allis-Chalmers Manufacturing Company

Milwaukee, Wisconsin

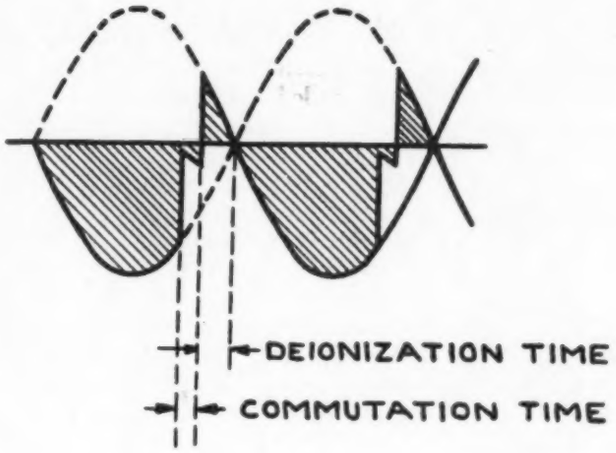


Figure 3 — Angle of adjustment required for the grids is shown in this wave diagram.

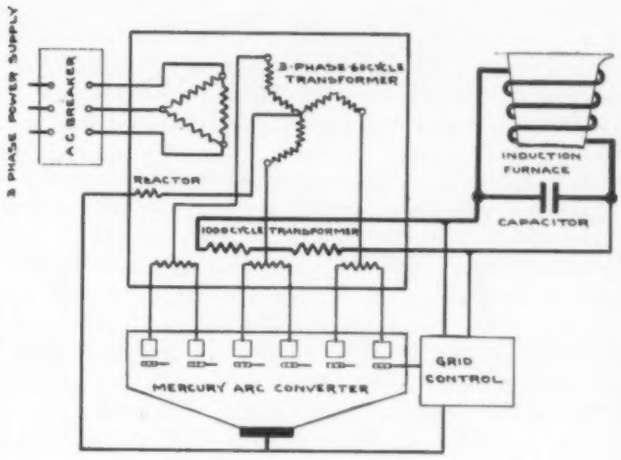


Figure 4 — The mercury arc frequency changer circuit can utilize 3-phase a-c power at any voltage and can convert it directly into single-phase, 1000 cycle, power.

heating of metals that these phases of the subject will not be reviewed. However, because mercury arc frequency changing equipment operating at a frequency of the order of 1000 cycles has certain limitations in heating metal pieces of small size and advantages in heating pieces of larger size, it will be of interest to consider the effect of frequency on the size of the metallic charge to be heated. Figure 1 is intended to portray only relative conditions, and like many considerations in connection with induction heating, exact efficiencies depend upon so many factors that it is not possible to draw general curves representative of all metals and conditions of heating.

The interesting facts brought out by the curves of Figure 1 are that for heating very small pieces of metal with coils of about one-half inch to one inch in size, it would be desirable to use in most cases a high frequency such as obtained by a high vacuum tube oscillator operating at a frequency of several hundred kilocycles. These high vacuum tube oscillators have a conversion efficiency of only about 65 per cent which when multiplied by an inductor coil efficiency, for example of about 80 per cent, results in an overall efficiency of only slightly over 50 per cent. It is apparent that it would not be desirable to induction heat a bar of metal several inches in diameter for melting or forging if a frequency converter of better efficiency could be utilized; and, as a matter of fact, the depth of penetration of the induced currents in the metal also effectively limits the size of metal piece that can be "through-heated" with a high vacuum tube oscillator operating at radio frequencies.

The next curve indicates that a motor-generator operating at about 10,000 cycles frequency would be preferable to use if the metal pieces to be heated by an inductor coil range in size from about $1\frac{1}{4}$ inches to $2\frac{1}{2}$ inches in diameter. The conversion efficiency of an average size 10,000 cycle machine multiplied by the coil efficiency would result in an overall efficiency quite a bit higher than that obtained from a radio frequency oscillator.

The top curve illustrates that for larger size pieces, mercury arc frequency changing equipment operating at 1000 cycles output would be more efficient, the conversion efficiency of this newly developed equipment being several per cent higher than that of a 10,000 cycle motor-generator set.

As previously mentioned, these curves show only relative conditions, and might be of some use in considering the heating of steel, but in heating other metals that are better conductors of electricity such as aluminum, for example, the maximum overall efficiencies would not be as high, but pieces of smaller diameter could be heated with each particular frequency.

Considering first the theoretical case of a grid controlled mercury arc converter assumed to change direct current power into high frequency power of the order of 1000 cycles, a description of circuit and wave diagrams is helpful. The most elementary circuit is shown in Figure 2. This circuit illustrates that a mercury pool

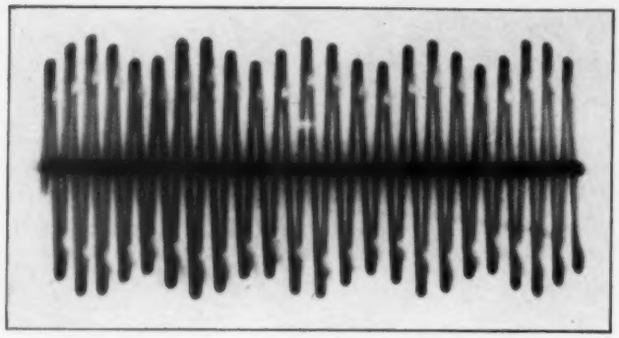


Figure 5 — The output wave shape is shown as caught by the cathode ray oscillograph.

tube with two anodes and their associated grids could be supplied from a source of d-c power through a center-tapped primary winding of a transformer, the secondary winding of which is connected to an induction heating load circuit. The d-c power could be obtained from any source; for example, a similar type of mercury tube with transformer equipment could be used to convert a-c power into d-c power at a voltage of about 2000 volts. The reason that the d-c voltage should be high is that a mercury pool tube has an inherent arc drop loss of about 20 volts, and this loss would be only one per cent if the supply voltage is 2000 volts, but would be about 10 per cent if the d-c power source had a voltage as low as 200 volts. The ratio of the primary turns to the secondary turns of the transformer shown in the diagram can be chosen so that the induction heating load circuit can be operated at any desired voltage.

The frequency of operation of the two-anode mercury arc converter will be determined primarily by the characteristics of the induction heating circuit. In order to enable the mercury arc tube to function as an electronic switch to convert d-c into high frequency a-c power, potentials must be fed back to the grids from the output circuit in proper phase relationship to high frequency potentials established on the anodes. The grid circuit includes a phase-shifter, grid transformer, current limiting resistors, and a source of d-c biasing potential.

To start inverter operation of the two-anode tube, the grid control circuit and transformer must be energized initially in some manner so that high frequency voltages will be applied to the anodes and grids of the tube. With proper starting control equipment, it is readily possible to "shock-excite" the induction heating circuit and set it into oscillation.

Figure 3 shows a sine-wave diagram which indicates the angle of adjustment required for the grids in relation to the sine-wave potentials impressed on the anodes when the transformer is magnetized and the circuit set in oscillation at the 1000 cycle frequency to which the output circuit is tuned. It is evident that each anode is released by its grid only near the end of the time that the positive part of the sine-wave potential is impressed upon it. The anode will continue to carry current when the a-c 1000-cycle voltage becomes negative because the positive potential from the d-c source is designed to more than offset the negative a-c voltage. However, after an anode has carried current for 180 degrees of a sine-wave, it is apparent that when the other anode is released by its grid, this other anode will fire and take the arc away from the anode that has carried the current, because at this instant, it is at a much higher positive potential. An anode on being released not only has the positive d-c potential impressed upon it, but it also is still at a positive point of the a-c potential wave also impressed on it whereas the other anode is at a negative part of its a-c wave. It is a characteristic of the operation of mercury arc devices of this type that arc current will be transferred from an anode at lower positive potential to one at higher positive potential when permitted to do so, and thus commutation, or electronic switching, of the arc current from one anode to another can be accomplished.

The transfer of arc current does not take place instantly for the reactance of the transformer winding and the loading of the circuit causes a delay before the current is entirely transferred from one to the other. The time of transfer is called the commutation time, and it is apparent in this diagram that the arc must be completely transferred before the a-c voltages reach the zero line axis, or else the voltages on the two anodes will reverse in potential, and the arc would not be commutated between them. The zero axis point where the voltages on the anodes reverse is termed the short circuit point, and the adjustment of the phase-shifter in setting the angle at which the grids release the anodes must never be so far back that commutation of the arc will not be completed before the short circuit point, or the inverter would not operate. In fact, commutation must be completed somewhat before the short circuit point in order to provide sufficient deionizing time for the grids, so that the positive ions near the anode that have just carried arc current so efficiently will have time to be deionized and the grid to attain blocking control, before the a-c sine-wave potential on this anode reaches the short circuit point.

It is evident that the deionizing time permissible at 1000 cycle frequency is of very short duration, of the order of only one twenty-thousandths of a second, so that the speed with which positive mercury vapor ions can be neutralized after carrying arc current determines the maximum frequency at which mercury arc equipment can be operated in induction heating circuits. At the present time, equipment of 300-kw rating has not been operated much above 2000 cycles frequency, but it is possible that further improvements in vapor pressure and temperature control and also in grid design will eventually result in using this type of converter at somewhat higher frequencies if desirable for particular applications.

As previously pointed out in connection with the circuit diagram of Figure 2, a two-anode or two tube inverter would have to be supplied from a d-c power source of about 2000 volts potential in order to offset the inherent arc drop loss of about 20 volts in the inverter tubes to the extent that they could be operated at a very high efficiency. The losses in the high frequency transformer with special design can be kept to a value of about 1 per cent, and the control power requirements need not be greater than 1 per cent, so that the overall conversion efficiency from the d-c supply terminals to the secondary output terminals of

the transformer connected to the heating load circuit could be about 97 per cent.

Because d-c power at 2000 volts potential is not available in industrial plants, steel mills, and foundries, and would have to be obtained by means of additional mercury arc rectifier equipment, another circuit has been developed which can utilize 3-phase a-c power at any voltage available in a plant and convert it directly into single-phase high frequency power of the order of 1000 cycles. This is the circuit actually used in connection with several 300-kw installations, and is termed a mercury arc frequency changer. The basic circuit is illustrated in Figure 4.

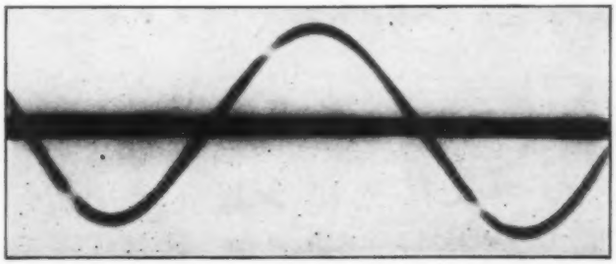
Instead of using just one pair of mercury arc inverter tubes or one two-anode tube, a total of six individual tubes or a six-anode mercury arc tank is required. Also, the high frequency single-phase transformer instead of having only one center-tapped primary winding is built with three center-tapped primary windings each of which is on the same magnetic core with the secondary winding.

The equipment is connected to the supply of 3-phase a-c power by means of a circuit breaker, operation of which energizes a 3-phase transformer equipped with a delta connected primary winding and a zig-zag connected secondary winding. If the supply system frequency is 60 cycles, for example, this transformer would be designed for 60-cycle service, the ratio of primary to secondary turns being chosen so as to operate the mercury arc converter at an equivalent voltage of approximately 2000 volts and thus attain a very high efficiency as previously described. Each pair of anodes connected to a center-tapped primary winding of the high frequency transformer operates when the 60-cycle sine-wave potential impressed on their winding is at higher positive 60-cycle potential than on the other two pairs of anode connections. Thus the arc current is commutated between a pair of anodes several times for the one-third of a 60-cycle wave, while the 60-cycle wave is at a positive potential, and thus is effectively equivalent to a d-c potential during this time. Because the secondary winding supplying the induction heating circuit is coupled to each of the three center-tapped primary windings of the high frequency transformer, high frequency power is supplied continuously to the secondary winding and to the induction heating furnace circuit.

The frequency of operation of the induction heating circuit depends fundamentally upon the inductance and capacitance of the heating circuit. One very nice feature of mercury arc inverter equipment is that the frequency is determined by the output circuit, so that if the frequency characteristic of this circuit changes during operation, the mercury arc inverter will automatically supply the frequency required by the heating circuit. This is of great value in heating steel for melting, because, during the process of heating, the effective coupling between the inductor heating coil and the steel charge changes, and the frequency in automatically adjusting itself to these changes makes it unnecessary to switch capacitors as is necessary when operating at a fixed frequency such as supplied by a motor-generator set.

Figure 5 is a cathode ray oscillograph reproduction of the output current wave shape from a six-anode mercury arc converter operated in the circuit of Figure 4 at a frequency of about 1000 cycles. Due to the fact that the potentials impressed from the 60-cycle a-c power supply system on the center-tapped primary windings of the high frequency transformer are the positive crest values of sine-waves instead of a pure d-c, it is evident that the output current is slightly modulated by a 180-cycle frequency.

Figure 6 — The shape of the wave is very close to that of a sine-wave.



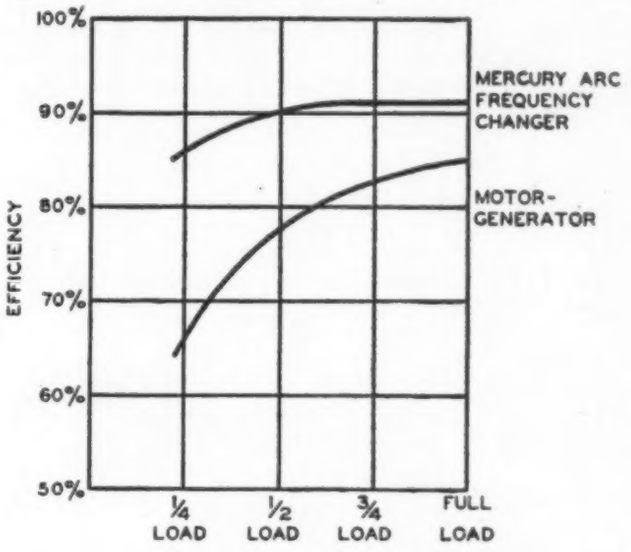


Figure 7 — The mercury arc frequency changer is more efficient than the motor-generator set.

Figure 6 is one cycle of this high frequency wave expanded on the cathode ray oscellograph screen to illustrate that the wave shape supplied to the induction heating coil is of good sine-wave form.

Figure 7 shows a comparison between the conversion efficiencies of mercury arc equipment and a motor-generator frequency changing set of average size. It is evident that mercury arc equipment is somewhat more efficient at full load, and when operated at reduced load shows an even greater advantage in conversion efficiency.

Figure 8 is a picture of a 300-kw mercury arc unit with a water-to-water heat exchanger for automatic temperature control.

Figure 9 shows a transformer for a 300-kw installation for operation from a 6900-volt, 3-phase, 60-cycle power supply system. The 60-cycle, 3-phase transformer, 1000-cycle single-phase transformer, and cathode reactor used

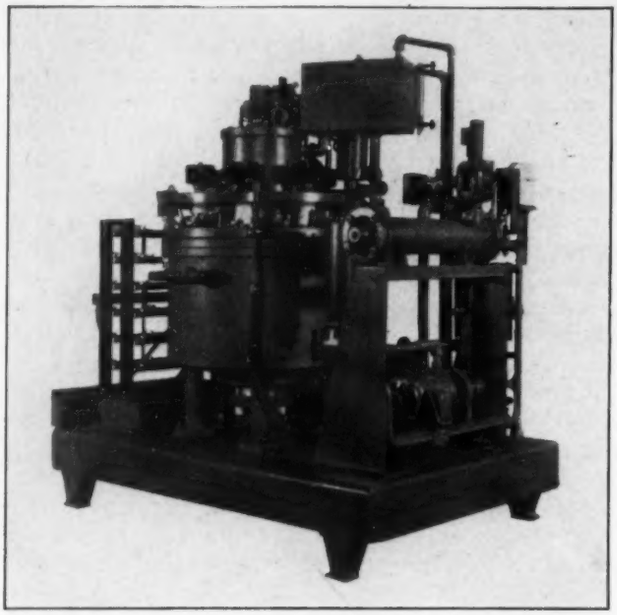
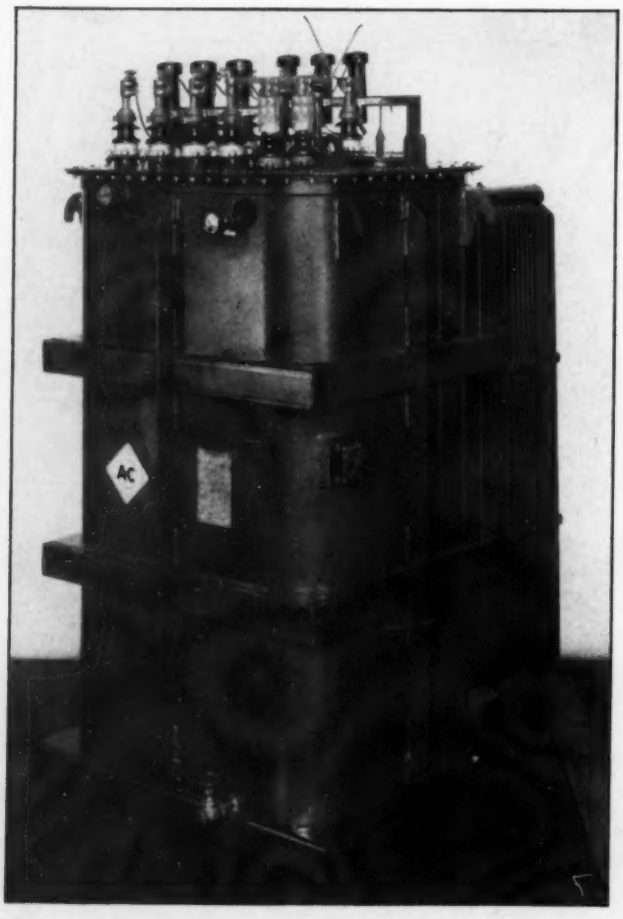


Figure 8 — The mercury arc converter for 1000 cycle induction heating service has a water-to-water heat-exchanger for automatic temperature control.

▲

Figure 9 — The transformers and the cathode reactor are assembled in one unit.



in the circuit are all contained within a single transformer case.

Figure 10 shows a group of induction melting furnaces operated from mercury arc frequency changing equipment for the production of centrifugal castings. Metal is poured from the furnaces into small ladles which are carried across the aisle in front of the furnaces to the centrifugal casting machines. Figure 11 is another picture of this installation showing an induction furnace in the foreground, and the pouring of molten metal into a centrifugal casting machine in the background.

INDUCTION HARDENING

Brief mention is made of the use of mercury arc induction heating equipment for surface hardening of steel only to indicate the advantages as well as the limitations in applying it for this use. For surface hardening to depths of only a few thousandths of an inch, high vacuum tube oscillators operating at several hundred kilocycles frequency are used to advantage, because the induced current penetrates to such shallow depths that all heating is confined to a zone near the surface. For hardening to depths of a small fraction of an inch, motor-generators operating at about 10,000 cycles frequency are widely used. If the depth of hardness must be of the order of nearly one quarter of an inch, a frequency as low as 1000 cycles can be employed where high power output can be obtained from mercury arc equipment.

Because of the frequency limitation in operating mercury arc equipment, it can only be applied to advantage for hardening of steel where a depth of hardness of the order of one-quarter of an inch or more is needed. Where a high power output is required periodically for very short intervals of time in hardening operations, mercury arc converters would be highly efficient due to the fact that no-load idling losses are much lower in comparison to other types of frequency conversion equipment.

INDUCTION FORGING

If 1000 cycle power is induced in a steel bar less rapidly than when surface heating for hardening, the heat will be conducted to the center, and the bar can be "through heated" for upsetting or forging. In order to attain a relatively uniform temperature throughout the bar at the time it has been heated to a forging temperature of 2250 F, a heating time of approximately two minutes is needed for 3 in. diameter stock, and somewhat longer times are required for heavier stock. If heated more rapidly with too much power, the surface would be overheated before the center would reach a sufficiently high temperature for forging.

In applying mercury arc frequency changing equipment to induction forging, as many as six heating coils have been operated simultaneously from a single 300-kw unit. Using several coils is of particular advantage when heating only the end of shafts or manufactured parts for an upsetting or press forging operation. When heating stock that has been sheared into lengths of a few inches for drop forging operations, the pieces can

be fed through a single heating coil by automatic means, several pieces being within the coil at a time. The rate at which pieces are ejected when at forging temperature will depend on the size of the stock, the frequency of operation, the power applied to the coil, and the production requirements.

There are many advantages in using induction heating for forging, particularly where electric power cost is the same or not much greater than the cost of fuel for fuel-fired furnaces, so that induction heating will undoubtedly continue to expand in the forging field.

INDUCTION MELTING

Induction melting with high frequency power is being used in this country and abroad in the steel industry for melting some of the highest-grade alloy steels, such as heat-resisting steels, tool steels, magnet steels, ball bearing steels, etc. Induction melting is carried out on a smaller scale than melting in large open hearth or large arc furnaces, and so in comparing induction melting to other methods, the comparison must be limited in general to the production of high priced alloy steels in melts of a few hundred pounds to a few tons. The popular sizes of induction furnaces for production melting range from about 200 lb capacity up to 2000 lb capacity.

In remelting alloy steel scrap, it is possible to make melts in less time than with other methods of heating, and thus have less loss of valuable alloying elements due to oxidation. Heat is induced in the metal by eddy current losses due to circulating currents of high magnitude. Where heat must be absorbed from radiant energy as in other types of furnaces, there is a limit to the rate at which the metal charge can absorb heat without having detrimental effects on the metal itself or on the furnace lining.

Melting of steels containing high percentages of alloying elements in induction furnaces can be carried out to accurate metallurgical requirements, and successive melts can be made with uniform results. In many cases the amount of carbon in an alloy steel has an effect on the heat treating and workability properties, and induction melting is of great value where carbon must be kept within a very low limit.

Molten metal in an induction furnace is automatically caused to circulate due to electromagnetic action. When alloy additions are made to a molten charge, the stirring action results in creating in a minimum amount of time a homogeneous product, so that when the metal is poured, it is poured with the assurance that proper alloying quality has been attained throughout the entire melt.

Other factors of interest in comparing induction melting with other types of melting are that induction furnaces are relatively cheap so that several furnaces can be installed, at little extra expense, for operation from a single mercury arc frequency changer, and thus furnaces of various capacities can be used as required, or individual furnaces can be retained for making melts of special alloys without danger of contamination or the necessity of making "wash" heats. There is very little loss of radiated heat from the mercury arc unit or from the furnaces which are water-cooled, so that working conditions are usually better than they are around other types of furnaces. Also, there is practically no noise in connection with the operation of the equipment. The conversion equipment consists of static devices, presenting no vibration and air-filtering and air-ventilating problems, so that the cost of installation and maintenance is at a minimum.

Induction melting with highly efficient mercury arc conversion equipment offers many attractive possibilities for industrial plants, steel mills, and foundries to supplement other types of melting facilities or to provide a better means for the production of certain types of high priced alloy steels. The amount of electric power required for melting in an induction furnace is equivalent to that required for melting in an acid lined arc furnace of comparable size. Each type, in general, consumes from 550 kwhr to 750 kwhr of electrical energy per ton of alloy steel, the exact amount depending upon several factors such as size of scrap material, method of charging in furnace, condition of furnace lining, time necessary for deoxidation, pouring temperature, and whether or not it is an initial melt started in a cold furnace or subsequent melts started while the lining is still hot.

The size of an induction furnace is sometimes a limitation with respect to the type of scrap material that can be charged in it. A 500 lb capacity furnace has a diameter of only about one foot, and a 2000 lb capacity furnace of only about two feet, so scrap material must be of dimensions that can fit into the maximum diameter of the opening. Charging is easily accomplished at the top of the furnace which is often only covered during the end of a melt. The charge settles down into the furnace as molten metal is formed in the bottom, so that additional metal can be added. Skilled labor is not required for the operation of an induction furnace.

An electrical operator is not needed for the mercury arc equipment. It is not necessary to continuously watch meters, and frequently switch capacitors, to maintain power on a furnace as when operating with motor-generator equipment. A furnace is started and stopped by push-button control which functions to

Figure 10 — Mercury arc frequency changing equipment is used in the operation of these furnaces.

Figure 11 — The group of induction melting furnaces shown in Figure 10 are used in making centrifugal castings.

switch power on and off by electronic means through grid control of the mercury arc unit.

The thickness of the lining of an induction furnace is of importance in connection with its operation. A furnace with too thick a lining operates at a poorer efficiency and power factor than one with minimum thickness. It is for this reason that induction furnaces are not used extensively in melting low grade scrap where a large amount of refining to reduce sulphur, phosphorus and carbon must be carried out, because the refining operations usually cause too great an erosive action on the furnace lining. Excessive erosion limits the life of a lining, and makes it more difficult for this type of furnace to compete with a basic type arc furnace where a considerable amount of refining must be carried out. However, there are undoubtedly possibilities in improving lining materials for induction furnaces, and, in the course of time, it is likely that the major disadvantages of using induction furnaces for refining operations may be largely overcome.

For special heating problems other than hardening, forging, or melting, it is often necessary to make tests to determine whether or not induction heating will be satisfactory. It should be emphasized that the use of induction heating with mercury arc frequency changing equipment can provide many advantages, but a careful analysis of the problems involved should always be made before recommending it for untried applications.

DISCUSSION

PRESENTED BY

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FRANK T. CHESNUT, Secretary, Ajax Electrothermic Corporation, Trenton, New Jersey

A. SCHMIDT, JR., Industrial Engineering Divisions, General Electric Company, Schenectady, New York

GEORGE LOBS, Power House Foreman, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

M. B. ANTRIM, Electrical Engineer, Lukens Steel Company, Coatesville, Pennsylvania

S. R. DURAND, Application Engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

Walter H. Burr: It is hard for an old-timer to comprehend how you can control firing of these tubes to 1/1000 of a second. I am not, as an operating man, particularly interested in the design, but I am interested to a large extent in the operation, maintenance, and care of equipment of this nature.

I would like to ask at what temperatures these tubes can be operated most efficiently and at what temperatures the operation becomes critical. Also is there a definite demarcation in the size of tube which should be equipped with a vacuum pump and the tubes which are evaculated and sealed? What are the advantages and where is the point at which it is more economical to use one than the other? What is the life of the tube? This of course must be an average life, and when the tube fails, what is it that fails? At the present time is there any arrangement whereby tubes can be exchanged or rebuilt?

The author has stated that the tubes require less maintenance. We know what happens to the motor-generator sets, but what is there to look for to locate failures in the rectifier units?

H. H. Angel: What difference is there in the first cost of comparable sized units between the 10,000 cycle motor-generator sets and the 1000 cycle converters? For example, in induction heating, where you may want to use frequencies in the neighborhood of 10,000 cycles, it is generally claimed that a motor-generator set is cheaper than electronic devices. I am assuming that, in the case of this equipment, the same thing may hold true.

F. C. Schoen: Figure 1 shows efficiency points at various operating frequencies and in reading various papers on this subject, I find no mention of heating sizes above four to six inches. What is the maximum

charge that can be heated efficiently, and are there any published figures on this subject?

I am not entirely clear as to the method used in obtaining frequency control. In melting, as I interpret the figures, a tuned circuit is used. Must this circuit be adjusted for every size of melt, or charge, before applying power to maintain the desired 1000 cycle frequency? The paper also mentioned that the frequency may change over a range of about 1000 to 1100 cycles during the period of melting. What effect has this frequency variation on the stirring action of the furnace? We know some high frequency furnaces want to boil rather badly and I would like to know if frequency variation will affect that action making frequency adjustment necessary.

If ample 2300 volt power is available so that transformers are unnecessary for driving a motor-generator set, what is the comparison of costs between a 300 kw motor-generator set and a 300 kw mercury arc unit, with costs based on complete installation? Also, what are the differences in space requirements?

The paper mentioned that efficient units have been developed for approximately 500 kw. Can these units be operated in parallel to obtain power in the range of 1000 to 1200 kw, the same as now obtained with the use of motor-generator sets?

Frank T. Chesnut: We have been watching the development of this equipment for the last 15 years. In 1930, we had a unit built for us. Results were not too promising commercially, and since the generator equipment was satisfactory, the tests were set aside. We, as furnace engineers, are interested in any equipment which might improve the supply of high frequency current.

I have two questions. First, I would like to know how an equipment of the order of 300 kw, operating on a 1000 pound steel charge, behaves as the heating progresses through the various stages from cold iron to finished melt. What happens to the power factor and control for example? Secondly, I would like to know whether the rectifier equipment shows any more deterioration on this kind of service than on standard 60 cycle duty. Those interested in induction heating would do well to watch the rectifier equipment. It might be developed to have an advantage over generators in some fields of application.

A. Schmidt: I would like to add a few questions to those that have already been asked:

1. A good many years ago in operating glass vapor tubes at high frequencies, a certain amount of anode erosion was observed and I am wondering if Mr. Durand has noticed any such effect? Is this sufficiently pronounced to cause insulator trouble in the tanks that are being used?
2. Another question is relative to telephone interference that may be caused by this application. Is there any experience that indicates that the high frequency may get back on the 60-cycle system and cause trouble where there is telephone exposure?
3. I am also interested in the case of charges of ferrous material. Dr. Durand spoke of brass and non-ferrous alloys, with inductance changes which caused a 10 per cent change in frequency during operation. With certain ferrous alloys, I am wondering if the inductance change is great enough to cause any trouble due to the frequency variation during the melt.
4. Mr. Durand indicated a limit of the order of 300 to 500 kw. The units which we have seen in the present application were all six-anode units. Is there any basic reason for limiting the output to the output of six anodes? I am wondering what the experience has been in that respect, whether the output could not be expanded to any desired extent by using sufficient anodes.
5. Lastly, everybody who has operated vapor converters has experienced converter failures, rectifier failures due to anode conduction in both directions, and inverter failure when the anode fails to commutate. Such a failure would occur if the deionization time were not long enough. What is the experience of these units? Do inverter failures occur, and what means are taken to recover from them?

George Lobs: Does this electronic device require any voltage regulation, and if so, of what type?

M. B. Antrim: In regard to the utilization of the power developed by the mercury arc converter, he mentioned a concentric bus, and I wondered what difficulties might be encountered in the installation of such a transmission system around a shop. Mr. Durand also showed a battery of furnaces apparently attached to a single converter. In this connection can you operate a battery of furnaces or coils heating different sized objects, perhaps at different frequencies at the same time?

S. R. Durand: In regard to Mr. Burr's questions about operating temperatures, we operate 300-kw units at a water outlet temperature not higher than about 115 F. If we go higher than that we cannot maintain so easily a frequency of a thousand cycles, but could still oscillate the units at lower frequencies. If we want to operate at high output power and go up to higher frequencies, it is possible to run at lower water temperature.

We have single-anode excitron tanks used for rectification that run at several thousand amperes of current, and these pumped-type excitrons can be applied to high frequency inverter service. We have not determined as yet the maximum rating that can be established for these tanks. We have sealed-off excitron tubes for lower ratings. There might not be much benefit in using tubes for 1000 cycle heating (except possibly for forging) at less than 50-kw output, and I fear the cost might be higher than for motor-generator sets at this rating. The life of sealed-off tubes is a factor we have not yet determined. Many tubes have been running for several years in rectifier service. Each tube has a life warranty, and the price of a replacement tube depends upon the life obtained under the warranty contract. Failures in the operation of mercury arc converter units may be caused by minor difficulties in the control circuits, or ultimately by insulation or vacuum failures in the tubes.

As to Mr. Angel's question on the difference in first cost, I do not think I could answer that properly. I really do not know enough about the cost of motor-generator sets for this type of service. I think there might be an advantage with mercury arc converters of higher ratings if operated from high voltage power

supply systems, because it would not be necessary to have a step-down transformer bank as required for motor-generator sets. I believe mercury arc converters and motor-generators are about competitive in price at ratings offered now.

Mr. Schoen asked about using induction heating for large size pieces. Many induction melting furnaces have a diameter of about two feet, and 1000 cycle frequency is of particular value in heating all sizes of scrap metal that may be charged in these furnaces, because currents can be induced in individual pieces more efficiently with a frequency of this order than with commercial 60-cycle frequency. A few induction steel melting furnaces have been operated with 60-cycle power, but it is difficult to start these furnaces without having an initial pool of molten metal, and it is undesirable from a metallurgical control standpoint to retain a substantial amount of molten metal after each melt in order to facilitate starting the next melt.

The frequency at which mercury arc converters operate depends primarily upon the number of turns of the induction coil and the amount of capacitance connected across the coil. Operation can be at a frequency as low as 100 cycles if enough capacitance is available. Mercury arc converters have been run at around 2000 cycles at good power output. The range can be adjusted by design of the inductance and capacitance of the elements of the heating circuit.

A change in frequency of only about one hundred cycles while making a melt of steel does not have a noticeable effect upon the amount of stirring action. The frequency change would have to be much greater before an appreciable change in the stirring action could be observed. The lower the frequency of operation, the more active is the stirring of molten metal.

When installing mercury arc converter equipment, the transformer is normally located outdoors and the only space required in the building is a space possibly 10 × 20 feet for the mercury arc unit and capacitors. The latter can be stacked on a frame several layers high if space is at a premium.

Mercury arc units can be operated in parallel at a thousand cycles frequency. However, from a cost standpoint, a higher capacity excitron unit might be preferable in most applications rather than paralleling several smaller units.

Mr. Chesnut asked about the behavior of mercury arc equipment supplying power to a furnace as it goes through the melting stages. I think the effect is somewhat the same as it is with a motor-generator set; the power tends to drop off on the furnace as the charge becomes non-magnetic and to build up again as molten metal is produced. The power factor remains constant so that no electrical control operations are required during a melt.

In connection with Mr. Chesnut's question of whether operation of the mercury arc units shows more deterioration in this kind of service than with ordinary rectification, I believe the answer would be that there is less chance of having such an effect because we operate high frequency units at high voltage and low current whereas most of our mercury arc rectifiers are run at very high currents at 250 volts or 600 volts d-c. In rectification service, arc drop losses are a much higher per cent, so the amount of heat loss on this account is much greater, and it is heat losses in the tanks that have the greatest influence on deterioration. It has been a practice with some users of pumped-type high power rectifiers to have them overhauled after about six to eight years' operation, although a great many are operated for much longer periods of time before being overhauled.

Mr. Schmidt asked if there was any erosion effect noticed on the anodes. After only a couple of years' operation in high frequency service, I do not think there has been any observable erosion on the graphite anodes of the one or two units that have been inspected. I will say it is very important to protect the grid insulation because if that becomes metallized, the grid control will be adversely affected. We have taken special pains to avoid difficulties of that sort.

We have had telephone engineers check the possibility of telephone interference from these units and they have made a couple of reports. In each instance, there has been no interference problem, and the distortion of current drawn from the power lines has been less than from a rectifier operated at the same output. The reason for this is that not only the odd harmonics are present that would be obtained with a rectifier system, but also even harmonics, and the harmonic magnitudes are so much less that the TIF factor is also less.

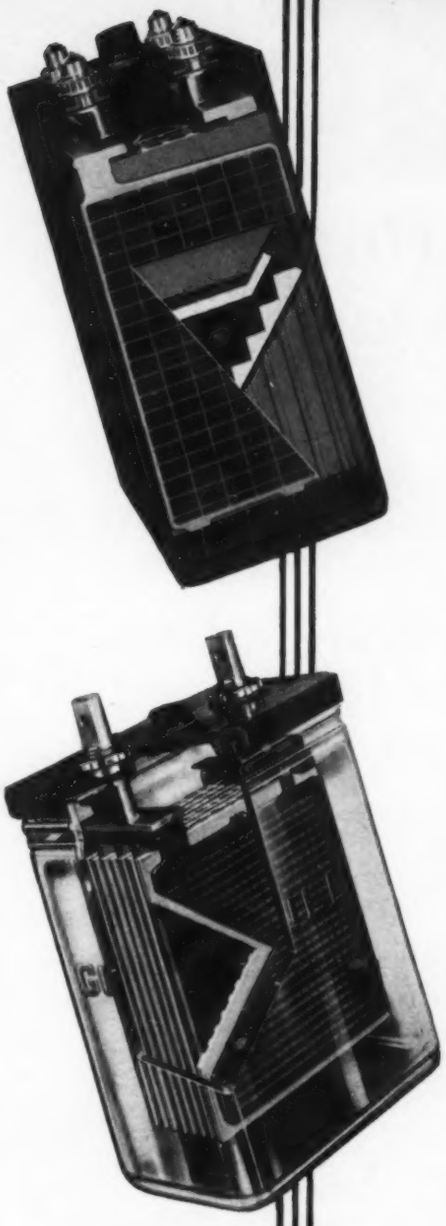
We believe that for very high outputs it would be advisable to use the single-anode excitron type unit. There is no difference in the circuit. For low outputs it would be possible to use single-anode sealed-off tubes or to use a two-anode tube. In using the ignitron instead of the excitron type of tube, it might be advisable to have a two-anode tube and only ignite at the 60-cycle frequency and have an auxiliary holding anode maintain the cathode spot. This would make the ignition circuit easier to operate than to try to ignite each cycle at a high frequency.

When using these converters in the circuit described, if inverter operation failure occurs, the next pair of anodes takes over so quickly that self-recovery usually takes place. That would probably not be true if a single pair of inverter tubes were supplied from a d-c power source.

Mr. Lobs' question was on voltage regulation. It is not necessary to use any voltage regulating device for most induction heating applications. However, if voltage regulation is desirable, a small automatic regulating device can be applied for operation in the grid circuit of the mercury arc converter unit.

Mr. Antrim has asked a question in regard to the use of concentric bus. It is desirable to feed the high frequency currents through concentric buses or cables to keep reactance drop at a minimum. Also, a concentric bus or cable possesses a high degree of self-shielding which would minimize the problem of inducing power into metal adjacent to these circuits. The outside conductor can always be grounded, so that installation of this type of conductor is relatively simple.

It is entirely feasible to heat different types of loads with mercury arc converter equipment, and furnaces of different sizes have been operated simultaneously. The frequency can be as much as 300 to 400 cycles higher when two furnaces are in service as compared to operation of one alone.



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Switches and panelboards stay cooler with Fusetrons—because Fusetrons have very much less resistance than ordinary fuses. Since heat produced by the flow of current is proportional to resistance—Fusetrons generate very much less heat than ordinary fuses.

This cooler operation means the elimination of needless blows and useless shutdowns that are the result of heating in fuses.

Cooler operation also adds to the life of switches and panelboards.

LOOK at the Resistance of Fusetrons compared to the Lowest Resistance Fuse

Chart shows resistance at full load in ohms.

Notice that fuses have 55 to 140% greater resistance than Fusetrons. That is why Fusetrons reduce heating—keep circuits in operation—prevent costly shutdowns.

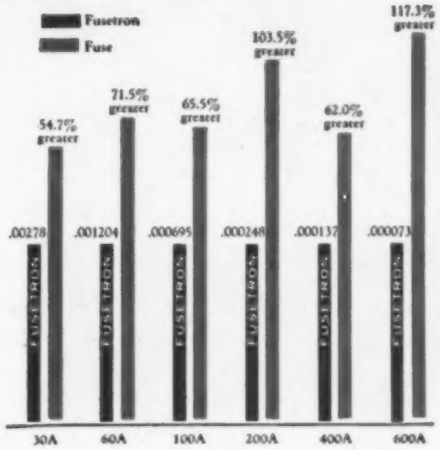

Chart shows 250 volt sizes. 600 volt sizes show similar results.

Fusetrons Give Many Other Kinds of Protection Heretofore Not Available

What Is the Fusetron?

The Fusetron is a dual element device—a fuse to which is added a thermal cutout.

The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriters' Laboratory approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses, Fusetrons fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in tamper-resisting type (Fustats) for 125 volt circuits.

Their cost is surprisingly low.

Fusetrons do everything fuses do, as is confirmed by the Underwriters' Laboratories' Label, and in addition

★ Provide simplest way to stop burnouts from single phasing. ★ Entirely wipe out needless blows caused by motor starting currents or other harmless overloads. ★ Give thermal protection to panel boards and switches. ★ Prevent needless blows caused by heating in panels and switches. ★ Protect motors against burnout. ★ Give double burnout protection to large motors. ★ Make burnout protection of small motors simple and inexpensive. ★ Permit use of larger motor or adding more motors on circuit without installing larger switch or panel. ★ On new installations, proper size switches and panels can be used instead of oversize. ★ Protect coils, transformers and solenoids against burnout.

Get All The Facts • Get Better Protection
Send the Coupon Now

One needless shutdown—one destroyed switch or panel—one burned out motor may cost you far more than replacing every fuse with a FUSETRON.

Don't risk such losses—protect your production schedules by changing over your entire electrical system to FUSETRONS.

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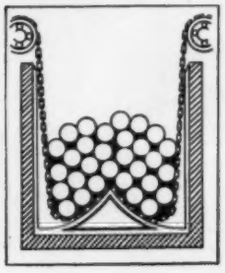
A "Sweet" Pickler



MONEL CHAINS *in the Weldco mechanical pickler move up and down alternately, revolving stock and exposing all surfaces. At left, Monel "spreader" which helps revolve load, crack oxide scale and increase agitation. Sprockets, chain, and tank trim are also Monel. (Fabricated by* Youngstown Welding & Engineering Company, Youngstown, O.)

● You've seen mechanical picklers before.

But have you come across one with all the features of this *Weldco* job?

Developed by the YOUNGSTOWN WELDING AND ENGINEERING COMPANY, Youngstown, Ohio, it handles everything from bars, flats and tubes to rounds, squares and hexagons. Automatically raises and lowers up to 10-ton loads at whatever speed you set. Cuts pickling time as much as 40 to 60 per cent.

Yet that's only the beginning. The *Weldco* mechanical pickler saves steam, acid, labor and maintenance besides.

Take the "spreader," a device that breaks up the load and makes it roll. This not only increases agitation, but also helps crack oxide scale. You get *faster* pickling . . . uniform action on *all* surfaces . . . reduce over-pickling . . . save steel.

The spreader — like all exposed parts of Youngstown's Weldco mechanical pickler — is made of Monel*. Experienced pickling room men know the *additional* savings that Monel makes possible.

For Monel withstands attack by hot sulfuric acid and other pickling solutions in common use by steel mills. It retains its high strength and resistance to corrosion. It assures more continuous operation . . . requires less time out for repairs.

You get these advantages, too, when you specify Monel for crates, racks, baskets, hooks, chain and accessories. Whether you measure loads in pounds or tons . . . whether you pickle sheets, tubes or castings, tiny screw machine products or heavy stampings . . . *Monel is the practical, economical metal for the job.*

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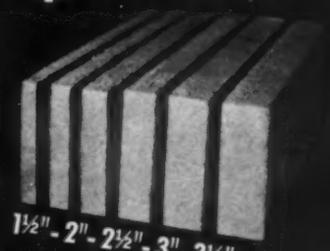
consistently leads all block insulations for temperatures up to 1900 F.



Superex blocks are finished in various standard sizes and thicknesses.

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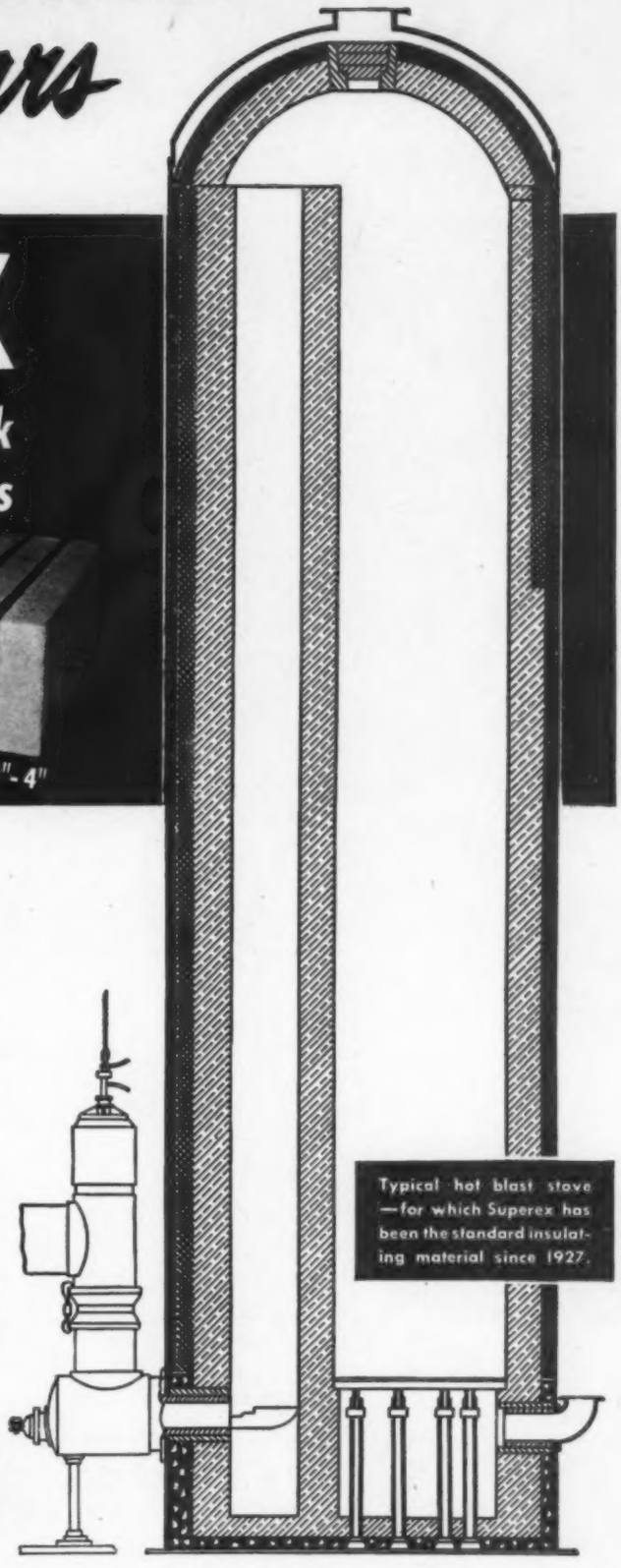

Typical hot blast stove —for which Superex has been the standard insulating material since 1927.

Superex has been the standard block insulation for temperatures up to 1900 F for over 20 years—used on more industrial high-temperature equipment, behind refractory linings, than any other block type of insulation.

Superex attained this success because it alone provides all these outstanding advantages:

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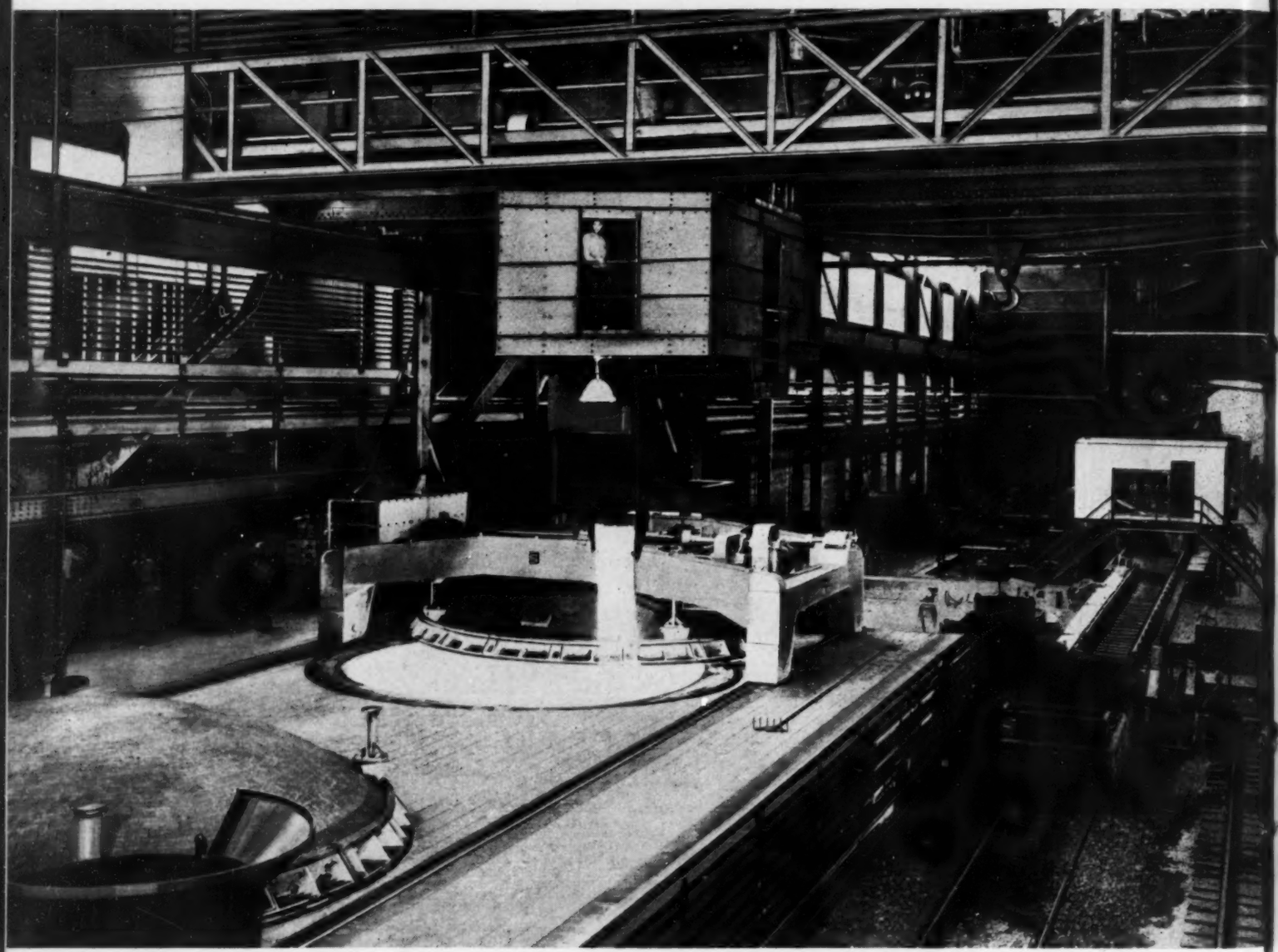
MORGAN 7½-TON, 81′3″ SPAN SOAKING PIT CRANE



Illustrated is a Morgan 7½-Ton, 6-Motor, 81′3″ Span, Stiff Leg Type Soaking Pit Crane. It serves a Morgan 36″ Two-High Blooming Mill which was furnished complete with auxiliary equipment. It is equipped with fabricated welded trolley and bridge trucks. Morgan Pit Cranes are provided with spur or worm gear operated trolleys and sleeve or anti-friction bearings as required.

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NEWS SUPPLEMENT APRIL, 1947

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SURVEY ON STORAGE SPACE INDICATES IMPORTANCE OF MATERIALS HANDLING

▲ What can a shipping superintendent or a warehouse supervisor do when incoming materials and outgoing products pile up? Storage difficulties — caused primarily by lack of balance between current production and existing facilities, by the shortage of freight cars and trucks, and by an over-abundance of some materials and shortages of others — are threatening to become a Number One headache for postwar industry.

One answer to this problem is indicated in results of a survey made recently for the Electric Industrial Truck Association. Boiled down, it amounts to this: Shipping superintendents and warehouse men are expanding *upward* in their use of existing storage space. Tiering of materials or finished goods to the maximum heights possible in receiving departments and shipping bays permits the use of valuable but oft-neglected storage room. Such material-handling equipment as battery-powered fork trucks is enabling warehouse and industrial storage workers to move mountains of materials and merchandise into storage, and thus to claim full utilization of building "air rights," while at the same time simplifying and speeding up both piling and removing material.

Case history reports show how this works. Merck and Company, manufacturing chemists, reported that "utilization of vertical storage space at the Rahway, New Jersey, plant has made construction of additional buildings for storage unnecessary," and that "the use of existing storage facilities was more than doubled." The ability of electric high-lift trucks to raise bulky, heavy loads to ceiling height and place them with fraction-of-an-inch accuracy means that this work can be done safely and easily and with large savings in cost.

A graphic example of the "tiering" answer to the storage problem is revealed in military experience with the biggest material-handling job in history. Official records show that investment of $50,000,000 in mechanical equipment — to do the work of 25,000 men who were not available — saved that amount in labor costs in *one year alone*.

"Through better utilization of stor-

BRITISH STEEL FIRM ESTABLISHES REST CENTER

A sign of growing recognition accorded in the industrial world to the value of welfare and rehabilitation work is the modern sanatorium established by Britain's biggest steel works at Gretton, near Kettering, for the benefit of its employees. The steel company has its works at nearby Corby, where iron ore workings and factory buildings extend over hundreds of industrial acres.

Gretton House, the rehabilitation center, could hardly be in greater contrast. It is a picturesque old mansion house, standing on its own grounds in rolling English country. All that is good in its architecture and design remains, but the bedroom accommodation has been modernized and other rooms converted for use as sick bays and a gymnasium. The latter is of particular importance, as great emphasis is laid on therapeutic treatment. There are likewise many opportunities for handicraft work and other occupational exercises.

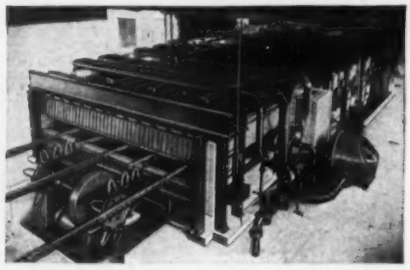
A staff of fully-trained physiotherapists and instructors is maintained. Some of the fitter men help to run the house by doing light housework and gardening.

R-S Furnace Facts

FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

New Furnace for Glamorgan Pipe & Foundry Company

A modern R-S continuous cast-iron pipe annealing furnace of the type shown is now under construction for Glamorgan at Lynchburg, the oldest cast iron pipe foundry in America. Pictured is discharge end showing control valves, Spencer Blower, and alloy fingers on conveyor. The unit shown is gas fired, and has a capacity of 30 to 120 pipe per hour, or 25 tons. The furnace is 22 feet wide and handles 20-foot lengths.



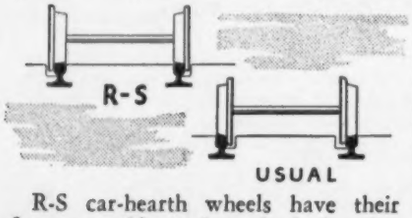
Similar furnaces are in use at U. S. Pipe Co. plants in Alabama and New Jersey; National Pipe Co. in Birmingham, James Clow Company, in Coshocton, Ohio, and the Lynchburg Foundry Company in Radford, Virginia.

A heater who lived in Duluth
Said maintenance charges, forsooth!
As high as they are
Demand we use R-
S Furnaces. Ain't it the truth?

In the Steel Industry, 8.2c per revenue dollar is the authoritative figure! R-S Furnaces help you to beat the average figure by a profitable margin.

P-D1

No Binding of Wheels with R-S Car Hearth design. The conventional type of support with wheel flanges inside the rails sometimes leads to binding when thermal expansion causes the hearth to spread and widen the wheel-gage.



R-S car-hearth wheels have their flanges outside so that wheels function easily regardless of thermal expansion.

FURNACE DIVISION
R-S Products Corp.
PHILADELPHIA 44, PA.

Round billets of aluminum alloy, awaiting use in manufacture of aircraft parts, are stored by electric-powered highlift platform truck in this manner in a plant storage yard. Material flow in process can be perfectly scheduled and efficient use made of material storage space off the production floor when the dependable electric truck is used to remove and return material between operations.

age space," the same report adds, "it was possible to store 30 per cent more supplies in existing space. If space utilization had not been increased to this extent, it would have been necessary to construct 40,000,000 square feet of additional warehouses. At a cost of $5 a square foot, that represents a saving of $200,000,000."

High-lift platform trucks and a special type of tiering skid permit the Copperweld Steel Company, of Glassport, Pennsylvania, to obtain more than double its former use of existing storage space in the shipping department. There, 5000-pound loads of copper-covered steel wire are stacked to await outward shipment. According to James A. Smith, general manager, "full use now is made of our hitherto wasted vertical storage space." The Copperweld fleet of eight industrial trucks "also assures a continuously smooth flow of materials in process, cuts costs of handling as compared with older methods, and keeps the finished product moving to the shipping department."

What can be done inside warehouses and storage buildings applies equally well to storage yards, the E. I. T. A. survey indicates. In one yard at an American Brake Shoe Company plant, an electric truck is used for moving and storing brakeshoe castings in pallet loads that are tiered to conserve space. The castings are stacked six high, with four stacks to each pallet, and the pallet loads are tiered four-high. Palletizing the castings — which are small but often difficult to store and handle because of their many, varied surfaces — permits efficient use of the industrial truck. A common truck load is 3800 pounds.

The case for tiering in order to utilize storage space to the maximum was ably put by C. F. Kells, educational program director for the Electric Industrial Truck Association, in an address September 6 to material handling engineers at a meeting sponsored by the Detroit Chamber of Commerce. He said:

"In setting up modern material flow systems, engineers will be vitally interested in conserving floor space. They will want to minimize the width of aisles between machines and between stacks of stored ware and material. They will seek all the height possible in storage piles. They will plan to use all the 'air rights' in their plants. If there is a 15 or 20 ft clearance in bays, they will want to use it all, if possible. This is natural because it avoids the need for new area and new capital investment."

The money-saving advantages offered by vertical storage are illus-

trated by a comparative cost study. Tiering of goods only six feet high, over a floor area of 100,000 square feet, would represent a use of $500,000 worth of space, at the usual computation of $5 a square foot for storage construction. By tiering 12 feet high, the same quantity of material or merchandise would occupy only 60,000 square feet — space costing only $300,000. By tiering 18 feet high, the floor area used drops to 46,666 square feet, representing a cost of $233,333.

Advocates of orderly tiering of goods say that this is only one of several ways in which the plant or warehouse operator may benefit through use of their storage "air rights." Such compact storage reduces plant congestion, permits greater flexibility in layout, and brings stored goods closer to production machinery and shipping departments. 4E1

CRUCIBLE LETS CONTRACTS FOR MIDLAND EXPANSION

▲ Further details are now available on the expansion program of Crucible Steel Company of America, as noted on page 115, December 1946, *Iron and Steel Engineer*.

Contracts have been let for facilities for large-scale production of stainless steel sheets and strip in its $21,000,000 expansion program at Midland, Pennsylvania.

One of the major contracts, and involving approximately $3,000,000, was awarded to United Engineering and Foundry Company for rolling mills. United Engineering will furnish a large amount of equipment which, with certain facilities of the steel company, will result in a hot mill train of four stands and cold mill installations which will include a three-stand four-high tandem mill and another four-high and a two-high stand.

Westinghouse Electric Corporation and General Electric Company each were awarded contracts involving about $1,000,000 for mill drives, with GE furnishing the hot mill drives and Westinghouse those for the cold mill.

American Bridge Company was awarded contracts for all the mill buildings, which will require nearly 5000 tons of structural steel. Seven cranes will be furnished by Cleveland Crane and Engineering Company.

REFRACTORY CONCRETE FOR 3000 F CASTABLES

▲ A concrete which easily withstands temperatures as high as 3000 F has been developed by the Babcock and Wilcox Company, officials of its refractories division announced recently. Known as "Kaocast," the product is being placed on the market after a long period of successful service trials under severe conditions. This product fills a need for a refractory castable in the construction of industrial furnaces operating at temperatures ranging from the top limit of standard refractory castables up to as high as 3000 F.

Both in service trials and in laboratory tests, the material has shown excellent stability and resistance to spalling disintegration) under repeated heating and cooling cycles, the announcement stated. Other properties which give durability include its exceedingly small volume change on initial firing, and its lack of shrinkage or expansion under continuous use at high temperatures.

Because it can be either poured into place like ordinary concrete used in construction work, or used as a ramming mixture, considerable savings will be effected in furnace construction. This is particularly true of furnaces requiring extensive use of special shapes which were formerly made of kiln-fired materials or of refractory plastics. The material can be used either for the quick fabrication of these special shapes, or to form part or all of the furnace lining.

The material is supplied in dry form, ready mixed, and requires only the addition of water to make it ready for use. 4E2

INLAND STEEL PRODUCTION PASSES 60,000,000 TONS

▲ Production of the 60,000,000th ton of ingot steel at its Indiana Harbor plant was announced April 2 by Wilfred Sykes, president of Inland Steel Company.

The record ton was one of 97.3 tons produced in No. 7 furnace of the No. 1 open hearth department and tapped at 10:50 a.m. The steel was of the

(*Please turn to page 123*)

SPC

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INDUSTRIAL HEATING PROBLEMS

From Soaking Pits to Forge Furnaces

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STEEL PROCESSING CO.

FORT PITT BRIDGE WORKS

Left—Type A Safety Switches 2, 3, and 4 pole; 30, 60, 100, and 200 amperes; 125, 250, and 600 volts; fusible types. Without interlocked receptacle for QuelArc plug.
Right—Safety Switch with interlocked QuelArc plug receptacle.

Heavy-Duty Safety Switches and Circuit Breaker Pylets

BUILT FOR MILL AND RAILROAD SERVICE

Circuit breaker Pylet with interlocked receptacle and QuelArc plug.

Pyle-National safety switches have the substantial construction needed to withstand severe operating conditions. The case and cover are heavy-section galvanized cast iron; operating parts are of heavy cast metal, and are designed for quick make and break action. Contacts are mounted on heavy slate. The operating shaft has bronze bearings. The case is fully protected, with both cover and hub plates equipped with weatherproof gaskets. The operating lever extends through the case in a rustproof bearing, and the cover is held closed by rustproof wing nuts and bolts. These features assure dependable service and long life even under severe operating conditions.

Circuit breaker Pylets are of similar heavy duty construction, and are available with or without interlocking receptacle for QuelArc plugs.

Write for Pylet general Catalog 1100 with complete listings.

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Mackintosh-Hemphill Company manufactures rolls for all types of ferrous and non-ferrous metal-rolling and forming operations. The engineering, metallurgical and manufacturing facilities of the Roll Division are engaged in developing and producing steel and iron metal-mill rolls of many types and alloys.

Mackintosh-Hemphill research is based on actual mill experience accumulated through many years of close coordination between mill operators and M-H roll designers, metallurgists, and technicians.

Striped Red Wabbler Rolls, made exclusively by Mackintosh-Hemphill, are manufactured under the "Techni" process of metallurgical control for all types of metal-rolling applications.

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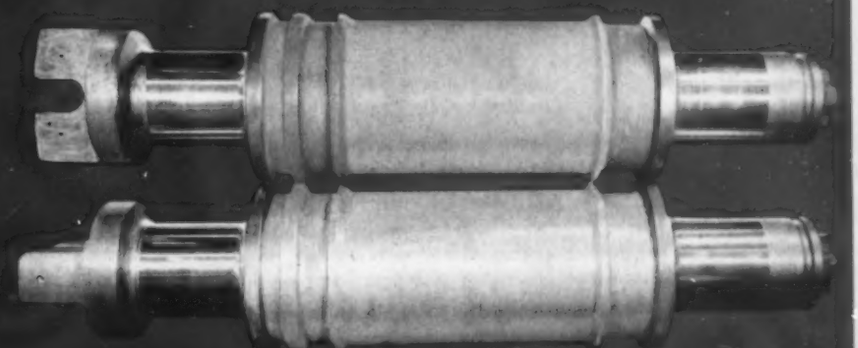
STRAIGHTENING AND FORMING ROLLS



BLOOMING AND BILLET AND BAR MILL ROLLS

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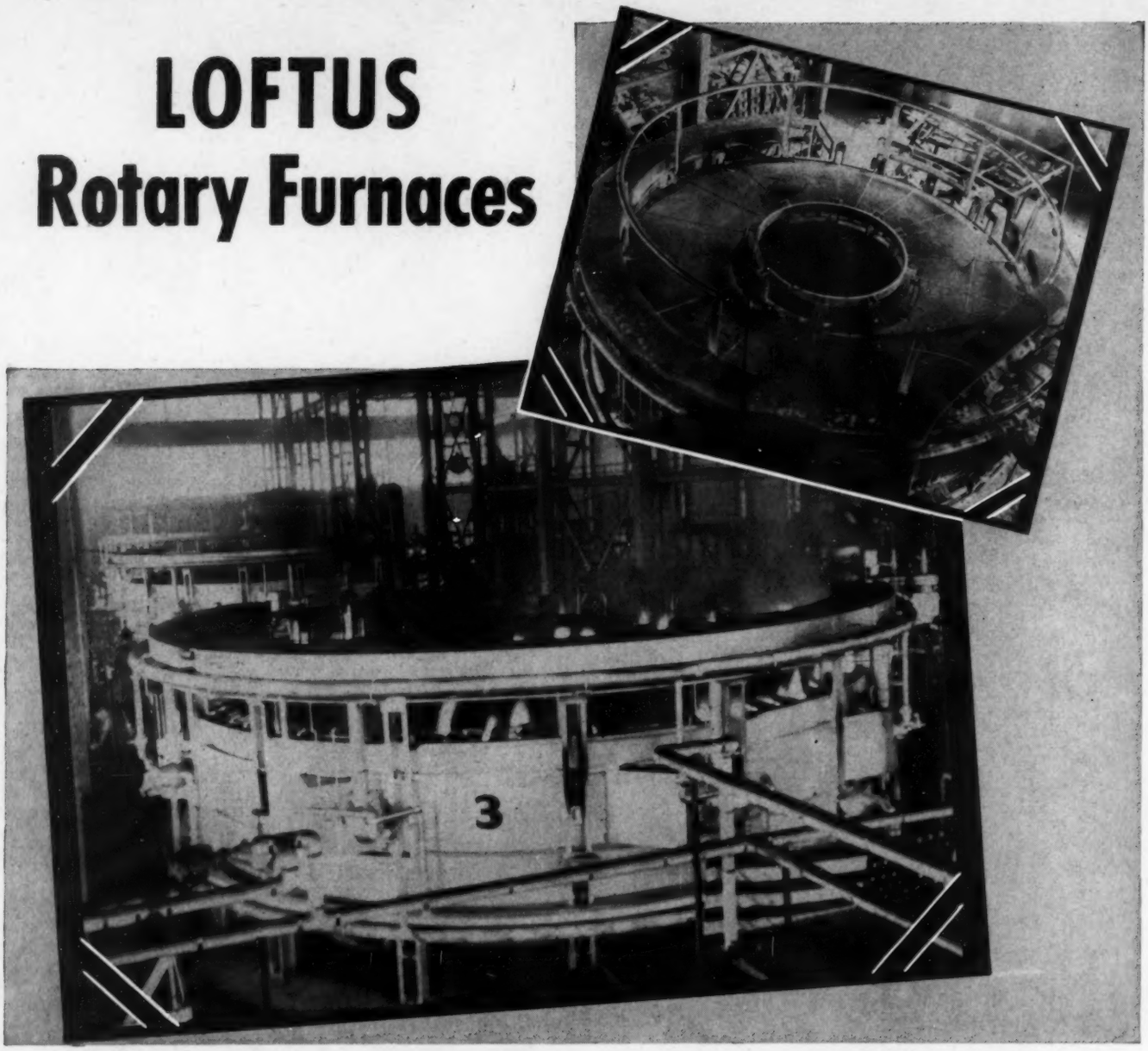
LOFTUS
Rotary Furnaces



For Forging, Annealing and Heat Treating . . .

In this Rotary Type Furnace firing is accomplished by means of eight natural gas burners, located in the outer wall only, with standby equipment for oil firing. Burners are set on an angle, to fire tangentially into the furnace chamber rather than radially. The burner arrangement permits of oil firing without deleterious effects on refractories. For the many heating jobs for which it is suited the Rotary Furnace performs with surprising efficiency. It is self emptying, requires minimum operating labor, heats 100% net production and under ordinary maintenance care repairs are negligible.

LOFTUS ENGINEERING corporation
610 SMITHFIELD ST. PITTSBURGH, PA
Designers and Builders
Engineers, Consultants, Contractors

(*Continued from page 119*)

type which will be rolled into angles in the 14-inch merchant bar mill.

The production mark was attained in slightly less than 45 years. Inland poured its first ton of steel ingots at Indiana Harbor on July 21, 1902. Twenty-one years were required to produce the first 10 million tons.

Growth of Inland, from its beginning in 1893 as a rail re-rolling operation at Chicago Heights to its present position as the seventh largest producer of steel in the United States, is illustrated by production and financial comparisons.

During World War I (the years 1917 and 1918), Inland produced 2,165,000 net tons at Indiana Harbor. During World War II (from December 7, 1941, through August 14, 1945) Inland produced 13,209,000 tons.

In 1902 the rated capacity was 60,000 net tons of ingots a year, while today the rated capacity is 3,400,000 tons.

Inland today, on the basis of the rated capacity of its blast furnaces, is the third largest producer of pig iron in the Chicago area.

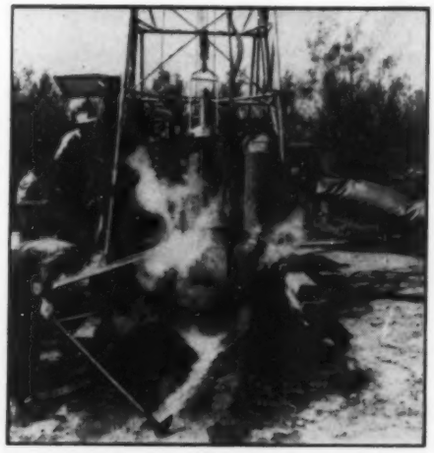
TEST FUSION PIERCING ON MESABI ORE RANGE

▲ A new method of making vertical blast holes in hard, low-grade iron ore, called fusion piercing, has recently been tested on the Mesabi Iron Range. Increases in drilling speeds of ten times that of older methods have been accomplished.

In fusion piercing a flame, produced by burning oxygen and a flux-bearing fuel in a special blowpipe, is directed against the surface of the rock or ore. The high flame temperature, about 4000 F. causes some kinds of rock to spall or flake off. Flux in the fuel causes other kinds of rock to melt. Pressure of the burning gases forces the molten material past a water spray where it is quenched and broken up. In the quenching process water turns to steam and the steam helps the gases force the quenched material out of the hole. Fusion piercing is a patented process, and was developed by the Linde Air Products Company, a unit of Union Carbide and Carbon Corporation.

Equipment for commercial use is still in the development stage. For field tests a truck was equipped with a portable oil-field drill rig with the 30 ft special blowpipe replacing the "kelly," and pumps, tanks, motors, and special recording instruments. A more compact and less complicated commercial machine will result when

A test run under way. The expelled granulated slag can be seen around the hole. The blowpipe is approaching a full depth pierce.



PICK THE RIGHT BUCKET

THIS CATALOGUE HELPS!

With hundreds of Blaw-Knox Buckets to pick from, it is easy to select exactly the right one for your conditions if you use Blaw-Knox Catalogue No. 2002. It lists factors to be considered and illustrates typical methods of installation.

The two-line hook-on type shown is one of those particularly adapted to slag handling in open hearth service. Other types, sizes and variations are described.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2040 Farmers Bank Bldg., Pittsburgh 22, Pa.

BLAW-KNOX CLAMSHELL BUCKETS

the apparatus that is on the experimental rig solely for the purpose of collecting data is eliminated. It is expected that commercial machines will be operated by a full-time operator and a part-time helper.

Field tests were made on Minnesota "taconite," an extremely hard, tough, abrasive, low-grade iron ore. Six-inch diameter holes up to 30 ft deep were fusion pierced at an average rate of 10 ft per hour, with rates as high as 17 ft per hour for short periods. This compares with an average speed of about 1 ft per hour for drilling holes of similar diameter in this ore.

Speed in making blast holes helps reduce mining costs in large-scale operations. In addition, it has been found that the high-temperature piercing flame produces stresses in the surrounding ore which causes better fragmentation during primary blasting, further reducing costs. 4E3

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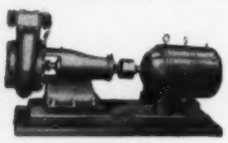
PEERLESS PUMPS

PEERLESS Centrifugal Pumps *(formerly Dayton-Dowd)*

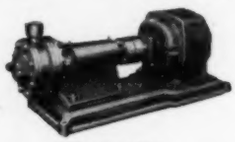
MEET extensive, continuous-duty pumping requirements in all Industries and Municipalities desiring advanced pump design, reduced operating cost and high pump efficiency.



Type DS

CENTRIFUGAL PUMPS

For Chemical, Oil, Food Processing, etc. Capacities: Up to 600 G. P. M. Heads to 230 ft.



Type XT

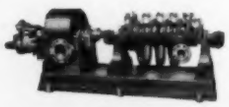
TURBINE (Vane) PUMPS

For Butane-Propane, General & Process Work. Capacities: Up to 150 G. P. M. For high heads.

Type A

CENTRIFUGAL PUMPS

For General Services-Maximum efficiencies. Capacities: Up to 60,000 G. P. M. Sizes: 2″ to 42″.



Type B

BOILER FEED PUMPS

For High Pressures in Refinery, Pipe Line & Boiler Feed Services. Pressures up to 700 lbs.

Type AF

FIRE PUMPS (*formerly Dayton-Dowd*)

Underwriters Approved. Capacities: 500 to 2000 G. P. M. One of a Variety of Peerless Fire Pumps.

Peerless Pump Division manufactures an extensive line of high quality centrifugal pumps for usual or unusual pumping applications. The Peerless staff of highly trained engineers or field representatives will gladly assist you in prescribing the proper pump for your specific application. If you are considering a pump installation demanding long range, trouble-free service, then Plan With Peerless – It will pay!

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BETHLEHEM STEEL DOUBLES STEEL MILL EXPENDITURES

▲ The Bethlehem Steel Corporation has allocated $37,500,000 for the development of iron ore properties and facilities, chiefly in Latin America, and expects to tap these new sources for substantial amounts of raw material "some time during 1948," according to the annual report for last year, sent yesterday to stockholders.

Included in its program are construction of ore storage facilities, trans-shipping stations and river vessels, work on which was delayed due to war conditions. During 1946 the corporation completed and placed in operation three vessels of 24,000-ton capacity taking ore to the United States. Four others are expected to be put in service this year.

Bethlehem had iron ore properties in Coquimbo, Chile; Camaguey and Oreinte, Cuba; Michoacan and Guerrero, Mexico, and Bolivar, Venezuela.

The company plans also to spend $125,000,000 for other improvements, additions and acquisitions of properties. It spent $64,431,470 last year for such purposes. Bethlehem's plant at Sparrows Point, Maryland, is to have new coke ovens, a blast furnace, two open-hearth furnaces, and additional tin plate finishing facilities.

HEAT EXCHANGERS FOR CORROSIVE CONDITIONS

▲ Seven tube "Karbate" impervious graphite shell and tube heat exchangers for use under highly corrosive conditions are now available from National Carbon Company, Inc., in three standard sizes of 4 ft 3 in., 7 ft 3 in. and 10 ft 3 in. length. All three units employ 1 in. inside diameter × 1½ in. outside diameter tubes in bundles encased in standard 6 in. inside diameter steel pipe shells. The exchangers are identical in every respect except for pipe length and the number of baffles, and all tube bundles and shells of the same size are interchangeable.

The units can be employed as heaters, coolers, boilers or condensers, and can be operated vertically or horizontally. They will carry temperatures up to 338 F and a working

pressure of 50 psi on both the tube and shell sides. Standard nozzle connections permit ready installation with piping connections of almost any material of construction. Water, brine or steam is suitable on the shell side.

"Karbate" impervious graphite has the well-known properties of high thermal conductivity (three times as high as carbon steel) and resistance to the action of most acids, alkalis, and other corrosive, solvent or reducing agents — particularly to all concentrations of hydrochloric acid and nearly all concentrations of hot sulphuric, phosphoric, and acetic acids, wet chlorine and the organic solvents.

The 4 ft 3 in. size has 8.2 sq ft of effective outside tube area, the 7 ft 3 in. size 16.4 sq ft and the 10 ft 3 in. size 24.6 sq ft. A unique feature of their construction is the combination of tube sheet, dome and nozzle into one monolithic piece, which eliminates packed joints for the corrosive liquid and reduces the number of gasketed joints on the fluid side to one gasket at each nozzle. 4E4

GAS TURBINE DEVELOPMENT TO HAVE SHOP TEST SOON

▲ Two experimental gas turbines, one a 5000 kw machine for electric power stations, and the other a 4800 hp unit are being constructed by the General Electric Company.

Alan Howard, G-E turbine-generator design engineer at Schenectady who headed design and development of the TG-100 Propjet, and TG-180 jet engines now powering the latest U.S. fighter planes, revealed that the company is also concentrating its facilities on gas turbine development in the nonaircraft field.

Shop tests of the 4800 hp turbine are scheduled to begin this spring. The stationary power plant is in the design stage and will not undergo factory test until 1948.

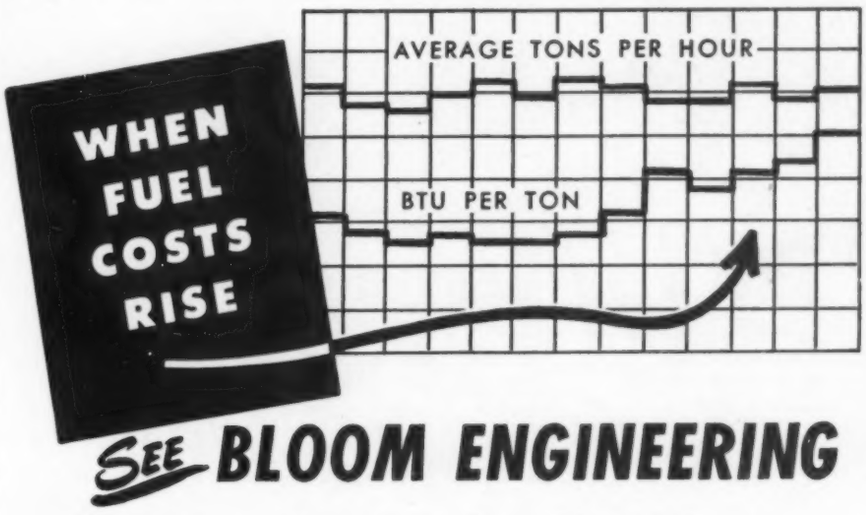
The 4800 hp gas turbine will burn bunker "C" fuel, although work is being carried on in the use of pulverized coal in order to permit more diversified application of gas turbines. The 4800 hp unit being constructed is approximately 19 feet long and weighs between 2½ to 4 pounds per horsepower.

In this stationary gas turbine, which also will be powered with oil, air flows through two compressors, an intervening intercooler, a regenerator and then into six combustion chambers. Nominal inlet temperature to the turbine is 1500 F, with the gases expanding first through a two-stage turbine which drives the high-pressure compressor. Turbine and compressor run at a constant speed of approximately 8700 rpm.

The rest of the expansion occurs through the single-stage low-pressure turbine which drives the low-pressure compressor. 4E5

CARNEGIE-ILLINOIS TESTS HOT TOP APPLICATIONS

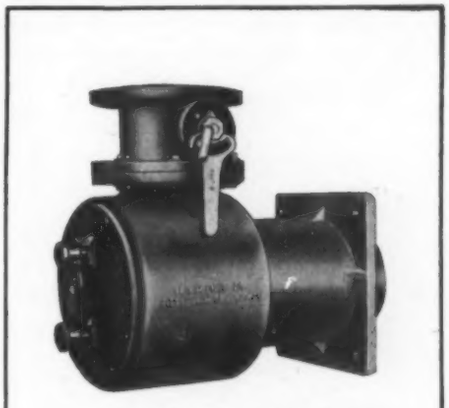
▲ "Advantages of various type hot tops in relation to ingot soundness" is the title of a paper by E. W. Pierce, chief metallurgist, South works, Carnegie-Illinois Steel Corporation, presented before American Institute of Mining and Metallurgical Engineers, Cincinnati, Ohio. Experimentation to compare the effect of type of hot top on resulting ingot soundness was carried out during a



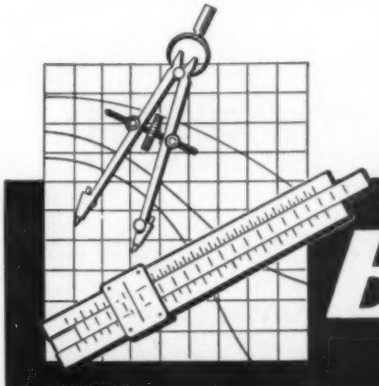
SEE BLOOM ENGINEERING

Fuel costs per ton of output are influenced by many factors —type and design of furnace, shape of roof, location of burners, kind of fuel, speed of charging and many other considerations. The correct balancing of these factors is a matter of experience and skill. Bloom Engineering has been dealing with the combustion problems in all types of heating furnaces.

If you want to reduce your fuel costs, increase production rates or improve the performance of your furnaces, see Bloom!



Bloom Long-Flame Burner. Efficient, luminous flame.



BLOOM ENGINEERING CO.

857 W. North Avenue Pittsburgh 12, Pa.

"That's an Unusual Handling Problem—Let's put it up to MATHEWS Engineers"

THESE plant engineers know that unusual handling problems require specialized thinking. They put such problems up to Mathews Engineers because such specialized thinking is the business of the Mathews people. They don't have a ready solution to every conveying problem, but they have acquired a wealth of material-handling experience in rendering industry a complete conveyer service for nearly half a century. In the great metal working plants of the United States and Canada, Mathews gravity and power conveyers and special conveying machinery are handling light and heavy loads smoothly and efficiently, and are paying dividends in increased production and lower costs.

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MATHEWS CONVEYER COMPANY WEST COAST
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recent six months' period at South works. This study was made on AISI-1045 open hearth steels poured in 25 in. × 25 in. × 71 in. big end up molds in four series. The first heat was produced using C & D tops with 14.5 per cent hot top volume on the first half of the ingots produced and clay with 15.5 per cent hot top volume on the balance. The second was made to compare the relation of C & D versus clay tops using equal volumes. The third was used to determine the effect of top-first rolling in a comparison of C & D versus clay topped ingots having equal hot top volumes (14.5 per cent). The other experimental heats had C & D tops with 14.5 per cent hot top volume on half of the ingots in each heat, and clay tops with 15.5 per cent volume on the balance. From this work it appears that a comparable product can be obtained using clay topped ingots with 15.5 per cent hot top volume or C & D with 14.5 per cent.

It is believed that approximately 15.5 per cent hot top volume is the minimum for individual blocking with ordinary clay hot tops. From our studies up to this time, it is apparent that due to the increased height and reduced cross sectional area the C & D hot top produces a satisfactory quality at approximately 14.5 per cent hot top volume. Our experience with the insulated clay hot top indicates that the hot top volume can be reduced with its use and a product of apparently equal quality is obtainable. Further study is to be made on this hot top application.

WESTINGHOUSE EXPANDS AT BUFFALO PLANT

▲ Plans to expand manufacturing facilities at the Westinghouse Electric Corporation's Buffalo, New York plant have been disclosed. The new operation, formerly a part of the switchgear and control division at East Pittsburgh, Pennsylvania, will be known as the industrial control division. Operations at Buffalo will eventually include motor, industrial control, copper wire and welding activities, and will be known as the Buffalo divisions, rather than the Buffalo motor division.

An additional 1500 persons will be added to the payrolls at Buffalo when

operations are fully under way, bringing employment to 7200 persons, with an annual payroll of $14,500,000. About 75,000 square feet of additional floor space will be added to the west end of the Buffalo plant, bringing the total floor space available for manufacturing to 1,700,000 square feet.

The new set-up, together with formation of the standard control division which plans to operate in a new plant at Beaver, Pennsylvania, will mean that more space can be made available for the transportation and generator, switchgear, and feeder divisions in East Pittsburgh. It is hoped that this arrangement will enable these divisions to increase their capacities by from 30 to 40 per cent. 4E6

NEW 25-TON POWER TRUCK REDUCES MANPOWER USAGE

▲ One of the most powerful industrial trucks ever built for handling forging and metals-stamping dies has been developed by the Elwell-Parker Electric Company and now is in production for 1947. It is rated at 25 net tons capacity compared with other models ranging from 2 to 15 tons.

Interest in these trucks has increased, reflecting renewed demand for forgings and stampings, especially in automotive, oil, aircraft, refrigerator, formed shapes for housing, and diversified commercial fields. The trend is toward use of larger power trucks for handling the heaviest types of dies, as these can be changed in less than half the time required by other semi-mechanical methods which employ more manpower.

Removing and replacing these large blocks of metal has been one of the

Platform of this 25-ton truck is 53 in. long, 72 in. wide.

The latest additions to the heat-beating Deltabeston wire and cable line are two new wire constructions for high heat extremes. Designed to stand up against gruelling infrared-oven heats, they are now available to help you tackle problems of moisture and temperatures up to 200 C (392 F). Rated at 300 volts and 600 volts, both types are fully silicone-treated, and are covered with tough glass braid. For a new answer to your wiring problems in high-temperature applications, write to Section Y63-446, Appliance and Merchandise Dept., General Electric Company, Bridgeport 2, Connecticut.

DELTABESTON
wires and cables
Built to beat the heat

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC

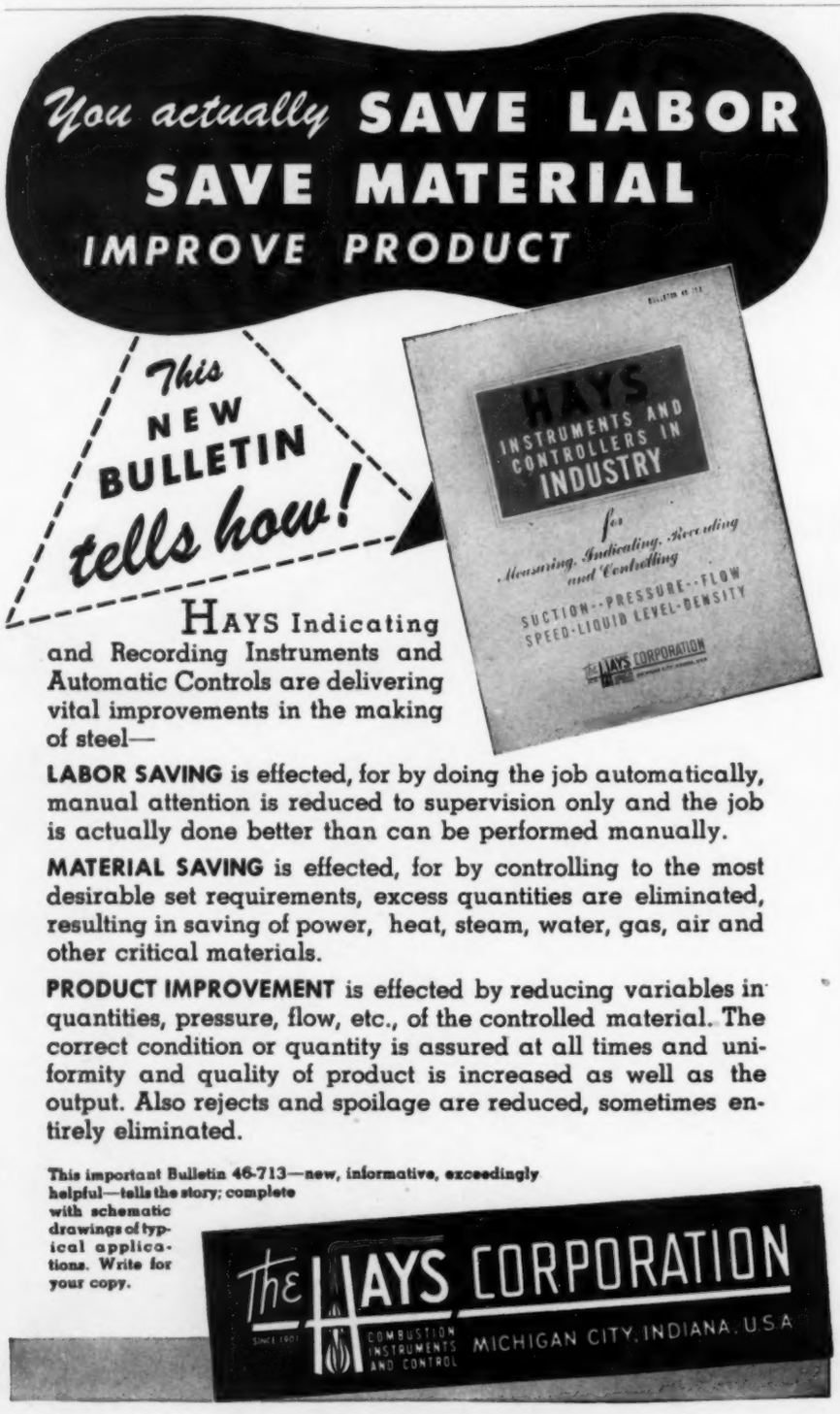
most dangerous, time-consuming and costly jobs in forging and metals-stamping plants. 4E7

ACID OPEN HEARTH RESEARCH CONTINUES

▲ The Acid Open Hearth Research Association held their regular bi-monthly session in Pittsburgh on March 10, 1947. Dr. Fitterer and the research staff presented the results of their recent work: the study of the effects of the furnace operations on the physical problems of high carbon steel, the correlation of data on the sulphur content of acid open hearth steel, some temperature measurement phenomena, the distribution of chromium between the slag and metal and the constitution of the chromium compounds in the slag, etc.

The question of the use of oxygen in the acid open hearth furnace is very prominent, and the association proposes to conduct research work on the subject at one of the plants of the association.

The total tonnage of acid open hearth melted for the year 1946 was 1,132,199 tons. This is a reduction of 20 per cent over that of 1945 which in turn was 27 per cent lower than that of 1944.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THE HAYS CORPORATION
HAYS Indicating and Recording Instruments and Automatic Controls are delivering vital improvements in the making of steel—
LABOR SAVING is effected, for by doing the job automatically, manual attention is reduced to supervision only and the job is actually done better than can be performed manually.
MATERIAL SAVING is effected, for by controlling to the most desirable set requirements, excess quantities are eliminated, resulting in saving of power, heat, steam, water, gas, air and other critical materials.
PRODUCT IMPROVEMENT is effected by reducing variables in quantities, pressure, flow, etc., of the controlled material. The correct condition or quantity is assured at all times and uniformity and quality of product is increased as well as the output. Also rejects and spoilage are reduced, sometimes entirely eliminated.
This important Bulletin 46-713—new, informative, exceedingly helpful—tells the story; complete with schematic drawings of typical applications. Write for your copy.
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USE STAINLESS STEEL IN INDUSTRIAL HEATERS

▲ Development of a stainless steel combustion chamber for its commercial and industrial direct fired heater has just been announced by Dravo Corporation. By using this material for combustion chambers, it is claimed that the life expectancy of these heaters has been greatly increased since stainless steel has such high resistance to oxidation.

While stabilized stainless steel has been used in high temperature work, such as ducts for direct fired turbines, this is believed to be the first time it has ever been incorporated in commercial and industrial space heaters. The vulnerable part of an air heater is the combustion chamber where oxidation from high temperatures may cause inefficiency and failure. The application of heat-resisting steel in this "Counterflo" heater not only will prolong its useful life, but will aid in maintaining high efficiency.

Refractory lining, which has always been considered necessary with carbon steel chamber construction, is completely eliminated in the new type. As a result, it is lighter in weight and more compact in size, making possible a much wider range of application. For instance, suspended heaters may be located in the building roof trusses, either vertically or horizontally, depending on the head room.

In this type of heating, warm air is discharged horizontally over the floor above the workers' heads at a flow rate of about 2000 fpm. This enables wide floor areas to be covered without the use of ducts. The flow rate of the returning air, coming from all directions, is so low that there is no appreciable draft even a few feet from the heater. This method of recirculating the air at working levels provides maximum worker comfort and minimizes heat losses through the roof.

Eight different sizes have been developed, ranging from 400,000 to

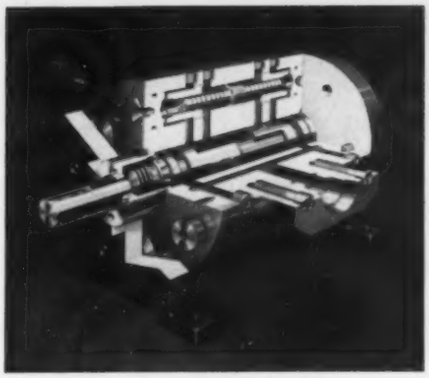
2,000,000 Btu per hour. All are of the same basic design and are completely equipped with modern safety devices. Dimensions range from 2 ft 7 in. wide by 4 ft 11 in. long by 8 ft 1 in. high for the smallest model, to 4 ft 9 in. wide by 9 ft 5 in. long by 12 ft 9 in. high for the largest. 4E8

PACKAGED POWER UNIT GIVES HIGHER PRESSURES

▲ A newly developed oil-hydraulic pressure booster, capable of supplying pressures up to 7500 lb, is announced by Hydro-Power, Inc., designers and builders of packaged hydraulic power units.

New fields of application in high pressure hydraulics are opened by the new unit, which makes available working pressures substantially higher than those normally obtained with high pressure pumps.

A compact, multi-plunger intensifier, the booster will multiply by as much as three times the pressure of the oil it handles in a hydraulic circuit. The power unit comprises a cylinder block having a nest of six parallel bores, each fitted with a reciprocating, double-acting piston. A central rotating valve member connects the pistons with the source of pressure fluid. As the valve rotates, the oil connections are made successively to the pistons, alternating from one end to the other to provide an uninterrupted pressure flow.



Easily installed, the new unit is expected to prove advantageous in a variety of applications.

The new booster operates without any appreciable increase in system horsepower, requiring additional power only for the rotation of the central valve. The drive shaft is an integral extension of the valve itself, providing a direct drive for the latter.

In operation, the valve is in complete hydraulic balance, entirely eliminating high bearing loads which are usually encountered in high pressure power equipment. 4E9

SHARON STEEL ORGANIZES DETROIT TUBE AND STEEL

▲ Sharon Steel Corporation announced the establishment of Detroit Tube and Steel Company, formed by merger of Detroit Seamless Steel Tubes Company and Bopp Steel Corporation. The new firm will function as a wholly-owned Sharon subsidiary.

The new operation puts Sharon actively in the Detroit market as a producer with annual capacity of about 100,000 tons of seamless tubing and cold-rolled strip. Approximately 700 men are on the payroll of the new firm.

In addition, Sharon operators in Detroit will henceforth include a new

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JONES SKIP HOIST DRIVES

FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications.

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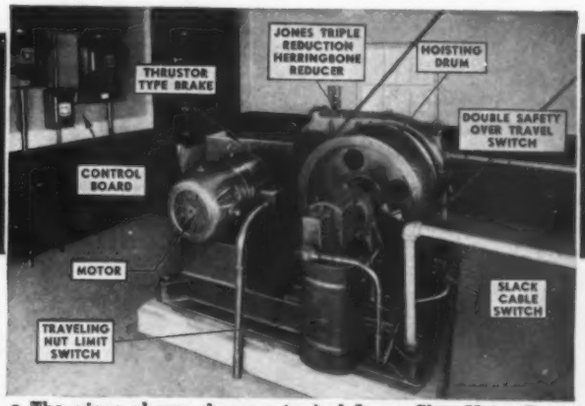
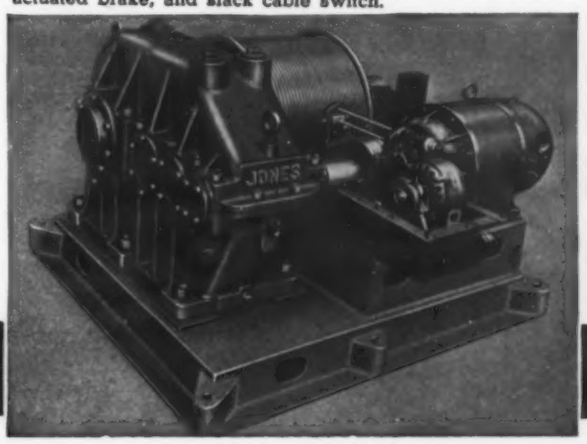


• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



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steel warehouse, Sharonsteel Products Company, which is carrying all the various types of steel produced by the parent company and its affiliates, which include the Detroit plants, the Niles Rolling Mill Company at Niles, Ohio, and the Brainard Steel division at Warren, Ohio.

Detroit Seamless Steel Tubes Company was established in 1900 and Bopp Steel Corporation in 1930. Their principal outlet is the auto industry, but large shipments are made to the railroads, the oil industry, household appliance companies and others.

LEWIS ROLLING MILLS ARE SOLD TO BRAZILIAN FIRM

▲ Lewis Foundry and Machine division of Blaw-Knox Company announced receipt of an order for rolling mill machinery from Laminacao Nacional de Metals, S/A, located at Sao Paulo, Brazil. The contract amounts to about one million dollars and covers two rolling mills and accessories.

POWER TRUCK VARIATION MOVES MASSIVE MACHINES

▲ Yale and Towne Manufacturing Company has developed a new variation of the heavy-duty power truck, designed for the easier manipulation of massive machinery and crates into carrying position by means of an integral roller-ramp and cable-draw system. The new device is called the gravity tilting platform type of electric truck.

As shown in illustration, the roller platform falls into ramp position when unlatched by the operator, and winch-drawn cables encircle the load to pull it onto the ramp and cause the ramp to rock back into the horizontal transporting position. Three pulling levels for the cable lines may be used, the lowest being direct from the cable drum (for very dense and low loads such as steel plate). The higher idler sheaves are employed to obtain higher purchases on such loads as machinery and bulky crates.

The roller platform falls into ramp position when unlatched by operator, and the load is winched onto the ramp. The ramp is then moved into transport position.

When empty, the roller platform is so balanced that virtually no effort is required to rock it into the horizontal position for empty return trips.

When running loaded, it is recommended that the pulling cables be left in position to hold the load engaged and prevent it from vibrating on the platform — and to save time in re-rigging for the unloading operation. This, however, is not necessary.

The truck body, the drive and the control equipment are all designed on the extra-heavy side. All six wheels are actuated by shockless worm-wheel steer. 4E10

SILICONE WINDINGS TRIPLE LIFE OF HOISTING MOTOR

▲ The application by National Electric Coil Company engineers of silicone products to the windings of motors and generators has now been tested in operation long enough to prove the original claim that extraordinary resistance to heat-deterioration results. Actual experience has shown time and again that, where a customer has had constantly recurring coil failures caused by excessive

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internal heat, coils engineered and fabricated to specifications for silicone windings practically eliminate the trouble.

A card record, from the electric shop files of the customer, shows the life of a crane hoist motor (and a duplicate replacement), equipped with conventional windings as compared to the same motor (and replacement) with silicone windings. It shows that conventional windings lasted from nine to eighty-three days, with an average life of fifty days. The silicone windings performed 312 days before

MOTOR SERVICE RECORD

Location: Cupola Crane — Application: Hoist Motor

Rating — HP. 15 — Amperage: 57A. — Frame: 90 — Style No.: 183496 — Speed: 600 — Winding: Series — Type: Mill & Crane — Serial: 2461MA. — Voltage: 250 — Bearing: Sleeve — Temp. Rating: 1/2 hr. 75°C

Date	Reason for Change	Length of Service	Type of Coils Armature & Field
6-30-43			Cotton-Asbestos & Cotton
7-23-43	Armature Burned Out	23 DAYS	" "
7-31-43	" " "	9 "	" "
9-6-43	" " "	36 "	" "
10-12-43	" " "	36 "	" "
1-8-44	" " "	77 "	" "
3-17-44	" " "	68 "	" "
4-5-44	" " "	23 "	" "
6-27-44	" " "	80 "	" "
9-13-44	" " "	78 "	" "
11-12-44	" " "	65 "	" "
2-8-45	" " "	83 "	" "
3-6-45	" " "	27 "	" "
4-24-45	" " "	46 "	" "
6-30-45	" " "	60 "	" "
8-1-45	" " "	71 "	" "
10-11-45	" " "	69 "	" "
12-8-45	" " "	58 "	" "
1-3-46	" " "	29 "	" "
3-5-46	" " "	64 "	" "
4-6-46	" " "	59 "	" "
5-26-46	" " "	19 "	" "
7-2-46	" " "	38 "	Silicone Mica & Glass
8-9-46	Bearing Failure	312 "	" "
9-1-47	(Still Operating)	(323 days elapsed)	

a bearing failure, which was no fault of the windings, and 323 days since then; they are still giving trouble-free service.

The cupola crane motor on which the above record has been kept is in a large steel mill. The crane is used to unload scrap steel. As is customary in applications of this type, the motor should be operated at full horsepower only 30 minutes per hour; otherwise the temperature of the motor will exceed its rated limit of 75 C above atmospheric temperature.

In this case, the crane operator was paid on a tonnage basis. Naturally, no attempt was made to allow the crane to rest half of each hour. After a number of failures of the windings caused by the overload, it was realized that a larger motor would prove more satisfactory. However, design limitations prevented this change and burned-out motors came to be accepted as inevitable.

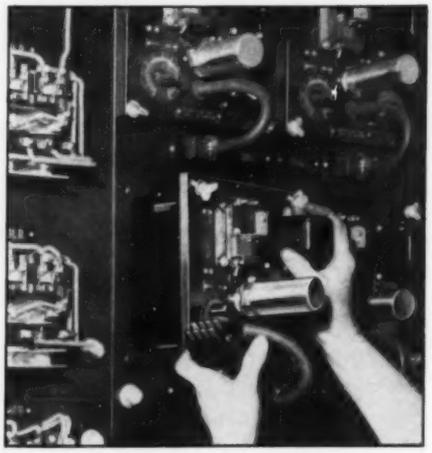
A set of armature and field coils of silicone-treated construction were ordered for the motor. Specifications called for the complete elimination of organic materials, and the use of silicone-and-glass insulated wire for the conductor, silicone-bonded glass and mica for ground insulation and an outside binder of glass tape. The whole coil was impregnated with silicone varnish.

The motor was wound by the customer and installed. Trouble-free service was experienced and the motor was soon forgotten. In fact, it was so completely forgotten that no oil was added to the bearings, and after it had operated five times as long as the previous average life, a bearing failed. At first it was thought that repairs could be made by replacing the band, which was torn off when the armature rubbed on the field coil pole piece. However, small pieces of banding wire had become embedded in the coils, causing shorts and grounds. An inspection of the coils, when they were removed, showed the insulation to be the same as new except for the above-noted mechanical damage. 4E11

QUICK-CHANGE UNIT PANEL EXPANDS ELECTRONIC USE

▲ A new development that greatly expands the usefulness of electronics for industrial applications is the Cutler-Hammer quick-change electronic control unit panel.

Of heavy duty construction especially adaptable to steel mill, rubber



Simplicity of design and better spacing of components on the panel decrease maintenance costs.

mill, printing plant and similar applications, the quick-change unit panel has been designed for rapid and easy servicing. The captive wing nut mounting and multiple contact plug arrangement permits instant substitution of a "spare" panel at any time to provide virtually uninterrupted machine operation whenever emergencies may arise that require removal of the electronic unit for testing or service-bench attention. Thus no costly shutdown of production machines results during maintenance operations. 4E12

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BOOK REVIEWS

▲ "Atmospheric Exposure Tests on Non-ferrous Metals" is a symposium recently issued by the American Society for Testing Materials describing and evaluating a wide series of atmospheric exposure tests carried out over many years on non-ferrous metals and alloys. A number of the tests have been underway for over ten years and the great amount of data which have resulted are here available so that American industry may make the best use of the results.

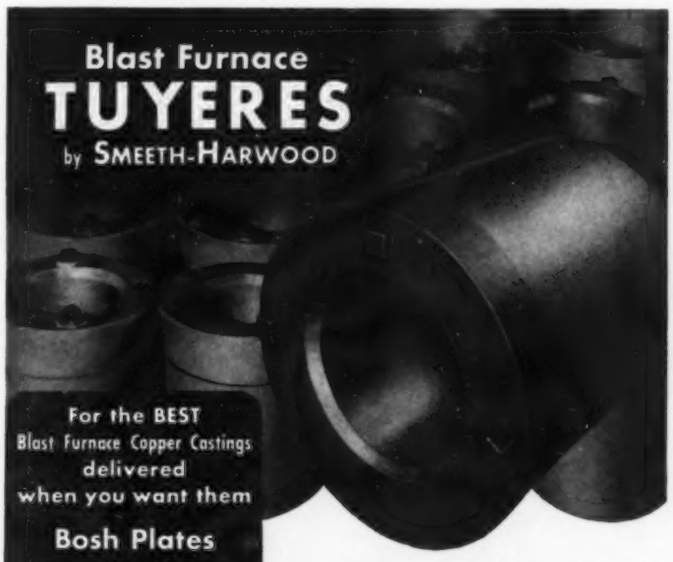
Like many of the ASTM books this 150-page publication includes considerable discussion by other authorities. Copies can be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania, in cloth binding, $2.25, or heavy paper cover, $1.75.

▲ "Jigs and Fixtures for Mass Production," by Leland A. Bryant and Thomas A. Dickinson, price $3.50, 222 pages, has been recently published by the Pitman Publishing Corporation, 2 West 45th Street, New York, New York. This book provides comprehensive and authoritative information on those manufacturing tools that are known as jigs and fixtures. It covers the subjects of plastics, pneumatics and hydraulics as these sciences are applied to tooling. The design and construction of jigs and fixtures and the various types of these, as well as tooling procedures, are all fully described. Particular attention is given to assembly tooling on which large scale production so largely depends.

▲ "Talks About Steel Making," by Harry Brearley, 236 pages, published by the American Society for Metals, price $3.50, is an informative and informal series of essays on various phases of steel making. The book is written as part suggestion, part history and part criticism by a man who has found steel making an attractive occupation. There are few chemical formulae in the book which make it useful in particular to the non-technically trained man. The book covers steel making and its various processes, as well as forging, testing, specification writing, and the fine art of "scrapalurgy." It is not a textbook, but is rather an interesting and rambling series of papers on the art of steel making.

▲ "The Dictionary of Machine Shop Terms," by Arthur C. Telford, 3 in. by 5¼ in., 292 pages, price $0.75, has been recently published by the American Technical Society, Chicago, Illinois. This dictionary has thousands of terms, which are used in the machine shop. Definitions given are brief, terse, and clearly defined in the "language of the trade."

▲ "Metallurgy" by Carl G. Johnson, published by the American Technical Society, Drexel Avenue at 58th Street, Chicago 37, Illinois, is the third edition of a practical survey text in metallurgy. This book stresses the importance of the physical and chemical properties of metal to anyone who is concerned with the designing, shaping, sizing and fabrication of metal products. In addition, the book has information on bearing alloys, aluminum alloys, alloy steel, copper and copper alloys, cast iron and heat treatment. The book is especially prepared for those who are working in industry. The cost is $5.00.



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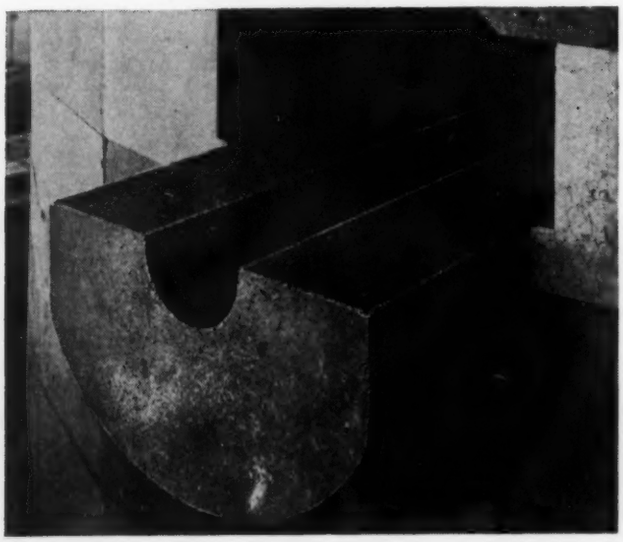

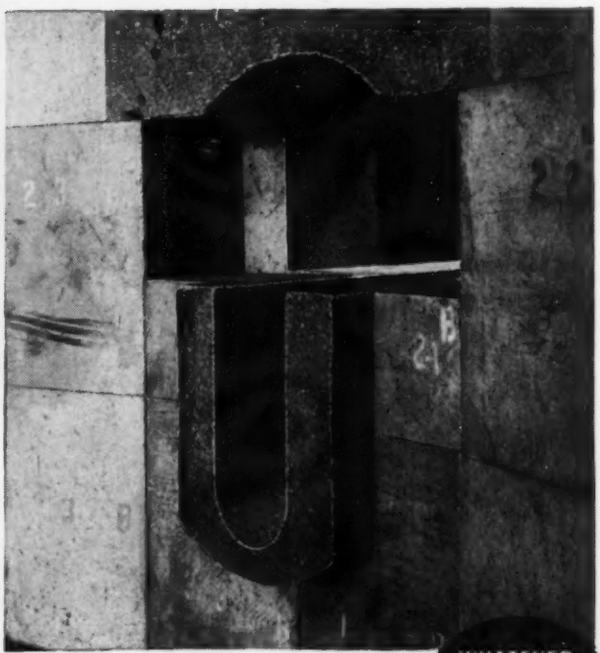

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Personnel News . . . .

T. W. Plante was appointed superintendent of the Jones and Laughlin Steel Corporation's Eliza department at its Pittsburgh works. Upon graduation from Carnegie Institute of Technology in June 1923, Mr. Plante started to work for J & L at its Pittsburgh works Eliza blast furnace department. In 1929 he was made assistant superintendent of this department. He was transferred to the J & L Otis works in Cleveland, Ohio, in 1943 as superintendent of blast furnaces, coke works and docks, which position he held until his present appointment.

Frank E. Rath was appointed chief engineer, effective April 1, of Carnegie-Illinois Steel Corporation's Duquesne works.

Mr. Rath, a native of Pittsburgh, is a graduate of Carnegie Institute of Technology, where he studied chemistry and, in 1935, received his bachelor of science degree. His service with this United States Steel Corporation subsidiary began in December 1936, in the main office as assistant chemist. In 1944, he was transferred to the Ohio works at Youngstown, Ohio, as assistant chief project engineer. In November of the same year, he was transferred to the Duquesne works as project engineer, the position he held until the time of his present appointment.

Mr. Rath is a member of the Association of Iron and Steel Engineers.

Albert H. Shonkwiler was appointed general manager of Bethlehem Steel Company's Lackawanna plant to succeed the late **Edward F. Entwisle.** Mr. Shonkwiler, has been assistant general manager of the Lackawanna plant since January 1, 1945.

Previously, he was superintendent of Bethlehem's huge sheet and strip mill at Lackawanna from 1935, when he joined Bethlehem.

All of Mr. Shonkwiler's business career has been in the steel industry. Born August 20, 1896, at Portsmouth, Ohio, he was educated in public schools of that city and at the Case School of Applied Science, where he specialized in metallurgy.

His first job was with the Otis Steel Company in Cleveland as a plant worker. His work was so outstanding that, at the age of 24, he became the youngest general superintendent of an Otis plant in the company's history. He remained with Otis for 18 years.

In 1931, he joined the Wheeling Steel Corporation at Wheeling, West Virginia, as strip mill superintendent. He came to Bethlehem from Wheeling.

C. B. Stainback was appointed industrial syndicate manager, a new position created to better coordinate the industrial sales activities of the Westinghouse Electric Corporation. Mr. Stainback, who was manager of the industrial sales department, has been with Westinghouse since 1910, the same year he was graduated from North Carolina State College. During practically his entire business career he has been associated with sales activities in the electrification of industry. The broad understanding of industrial electrification problems he gained during nearly 37 years of service resulted in his selection for the new position.

Born in Henderson, North Carolina, Mr. Stainback attended Henderson High School before entering North Carolina State College. After completing the graduate student training course at Westinghouse he was assigned to the contract section of the former industrial and power department in 1912. He became manager of that department in 1920 and in 1926 was made section head in the motor division. He was promoted to assistant sales manager of the industrial sales department in 1931 and seven years later was named manager of the department.

John E. Payne was appointed as headquarters industrial sales manager for Westinghouse Electric Corporation. Mr. Payne, who was formerly manager of industrial sales for the central district, succeeds C. B. Stainback who was recently named industrial syndicate manager to coordinate the company's over-all apparatus sales activities. Born in Phenix City, Alabama, Mr. Payne was educated in the public schools of Columbus, Georgia and at the Alabama Polytechnic Institute. He was graduated from the institute in 1925 as an honor student with a degree of bachelor of science in electrical

T. W. PLANTE

FRANK E. RATH

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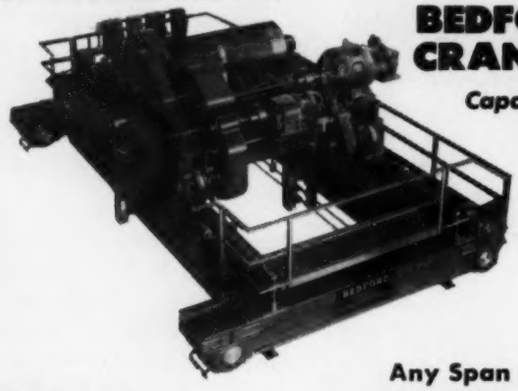

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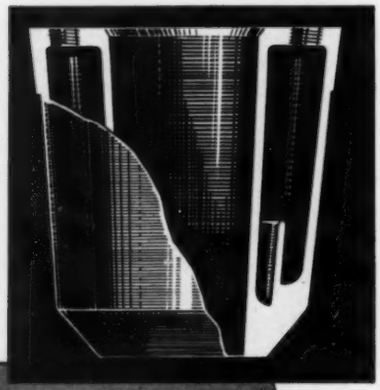

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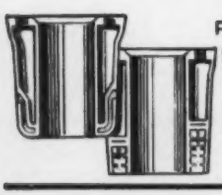

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engineering and joined Westinghouse immediately thereafter.

After a year on the company's student training course, he went into the general engineering department. He was an industrial salesman in the Pittsburgh office from June 1927 until March 1933, when he was appointed manager of the machinery resale section. In July 1934, he was named manager of industrial sales for the central district and remained in that position until his present appointment.

C. W. Bruce, formerly combustion engineer, at the South Chicago works of the Republic Steel Corporation and before that in the combustion engineering department at the Corrigan-McKinney works, was made assistant chief engineer at the South Chicago plant. Mr. Bruce is an active member of the Association of Iron and Steel Engineers.

C. W. BRUCE

Edwin L. Tindall was appointed chief engineer, effective April 1, of Carnegie-Illinois Steel Corporation's Edgar Thomson works.

Mr. Tindall, a native of Stuttgart, Arkansas, received his education at the University of Illinois, where he studied mechanical engineering and received his bachelor of science degree in 1929. After six years of service as a gas engineer with the Public Service Company of Northern Illinois, Mr. Tindall was employed at Carnegie-Illinois Steel Corporation's South works, Chicago, Illinois, as combustion engineer in 1935. In 1940, he was transferred to the Pittsburgh offices as steam, fuel and power engineer. In February of 1942 he was granted a military leave of absence for service in the armed forces. When he returned in April of 1946, he resumed his position and continued in that capacity until January 1947, when he was transferred to Edgar Thomson works.

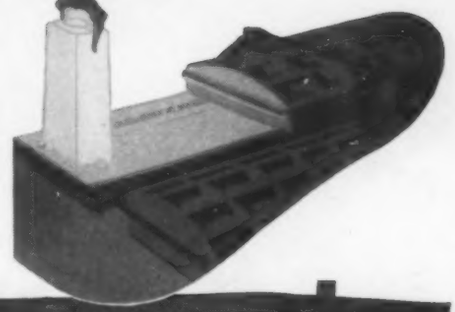
Mr. Tindall is a member of the Association of Iron and Steel Engineers.

J. S. McMahan has been appointed superintendent of blast furnaces at the Steel Company of Canada, Ltd., Hamilton, Ontario, Canada.

Olney Broun has been appointed assistant general superintendent of the Rustless division of the American Rolling Mill Company. Mr. Broun first joined the Rustless organization in 1936, as a metallurgist. Since that time he has been specializing in that field. In 1940, he

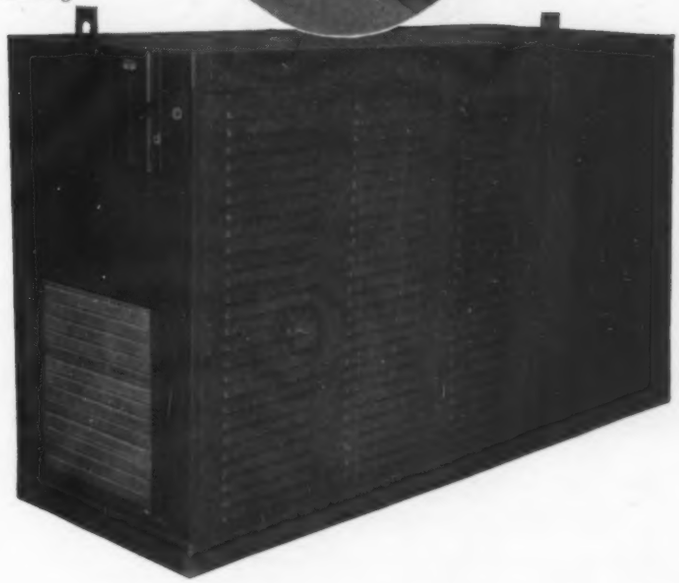
REDUCE CRANE OPERATING HAZARDS

Typical arrangement of DRAVO CRANE CAB COOLER on Soaking Pit Crane.



DRAVO CRANE CAB COOLER provides complete air conditioning functions, — cooling, dehumidifying, filtering, air circulating, fume-removing, winter heating.

Eliminate Heat-Fatigue **and** *Fume-Nuisance*



Crane cab air conditioning reduces operating hazards in soaking pit and other hot metal crane installations. Operators in air conditioned crane cabs are protected from fatigue due to extreme temperatures and from the physical discomfort brought on by annoying fumes.

In cooperation with several of the largest users of hot metal cranes Dravo has made exhaustive tests of crane cab air conditioning. When you buy DRAVO CRANE CAB COOLERS you will find these outstanding advantages, developed through research with successful operating installations:

- **Air-cooled condensers which completely eliminate water connections.**
- **Self-contained unit which requires electrical connections only.**
- **Forced ventilation of motor and control cabinet with cool filtered air.**
- **Mill-type construction of equipment, readily accessible for servicing.**

DRAVO

DRAVO CORPORATION

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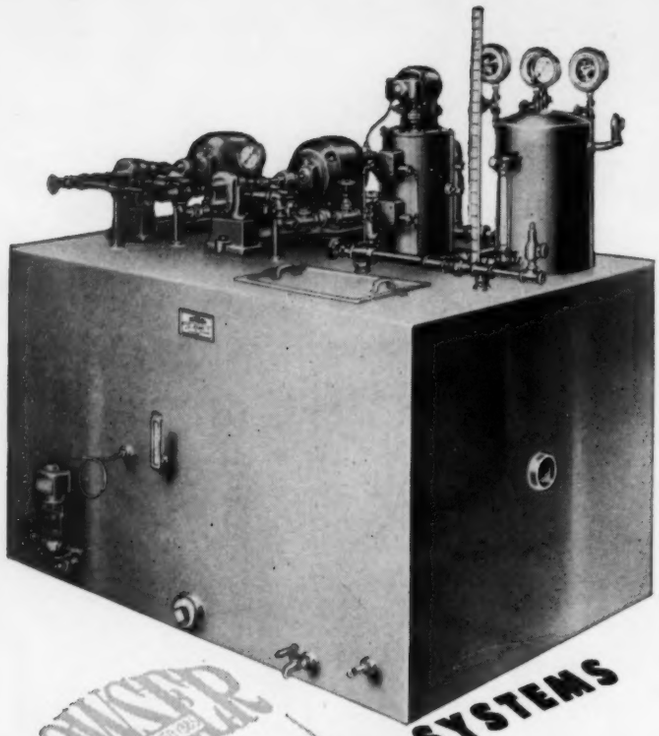

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Are DEPENDABLE • SUPPLIED IN ANY CAPACITY • FOR ANY JOB REQUIRING CIRCULATING, FILTERED LUBRICATING OIL •

There Is A Complete Bowser Lubricating System For Most Industrial Needs

More than forty years of knowledge and experience in designing and building industrial lubricating equipment are reflected in the dependable performance of every Bowser system.
Sizes range from self-contained units for individual machines to systems that serve entire plants.
Many steel mills and other industrial plants are using Bowser Lubricating Systems to provide a continuous supply of clean oil for important production equipment . . . to minimize maintenance costs and downtime.

A Bowser Lubrication Engineer will be glad to check the lubrication needs of your plant at your convenience. Write today to

BOWSER, INC.
1314 CREIGHTON AVENUE, FORT WAYNE 2, INDIANA

LIQUID CONTROL SPECIALISTS SINCE 1885

was named superintendent of the production metallurgical department, and in that capacity has been responsible for the control of metallurgical practices in all plant production departments.

Joseph W. Harvey has been appointed general sales manager of Vulcan Mold and Iron Company, Latrobe, Pennsylvania.

Peter V. Martin was appointed sales manager of the metallurgical department of the engineering and construction division of Koppers Company, Inc. Mr. Martin, who first became associated with the Carnegie-Illinois Steel Corporation in 1923, has been a special assistant in industrial relations for that corporation since the first of the year.

PETER V. MARTIN

During 1945 and 1946 Mr. Martin was a member of the American Military Government, serving in the metal section, as chief of the industrial branch, and finally as deputy director of the economics division.

Prior to his service with AMG, Mr. Martin served in various capacities with the Carnegie-Illinois Steel Corporation. He was stationed in that corporation's South Chicago works from 1923 to 1940. He became assistant superintendent of the blast furnaces in that works in 1930 and in 1938 was appointed assistant superintendent of the blast furnaces at Gary.

Mr. Martin attended Massachusetts Institute of Technology, where he specialized in metallurgy. He received a bachelor of science degree in engineering science from Armour Institute in 1938.

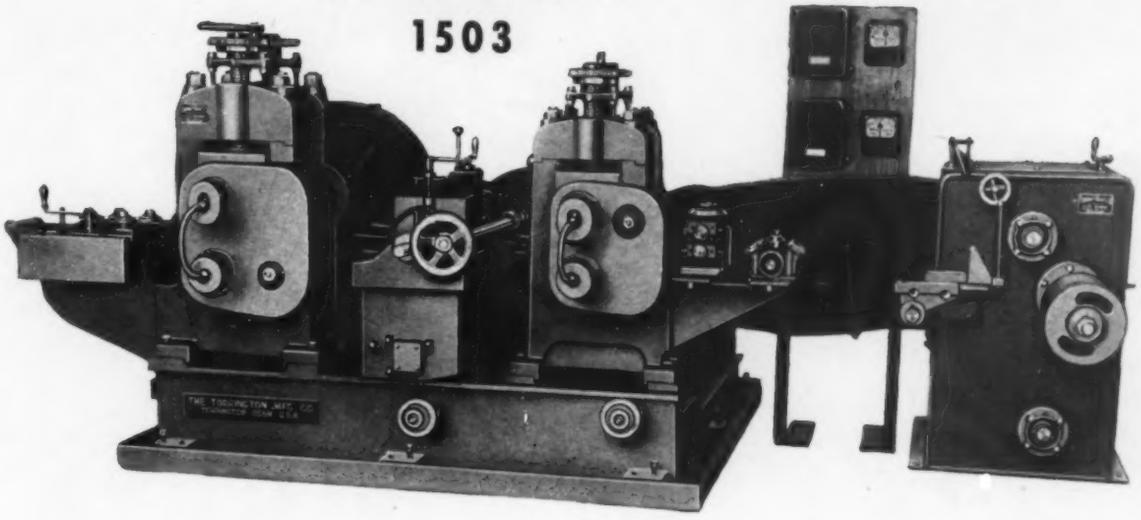
Robert W. Mehaffey was made assistant to superintendent of industrial relations, rates, with Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Mehaffey attended University of Pittsburgh and graduated from Geneva College with bachelor of arts degree in business administration in 1937. He has served in various capacities with the Duquesne works since 1943. Prior to his employment at that plant, Mr. Mehaffey served with the U. S. Army air corps.

William R. Howell was appointed general superintendent and **Mathias J. Meinen** was appointed assistant general superintendent of the Midland works of the Crucible Steel Company of America.

Mr. Howell has been connected with the Crucible plant since 1921, when he came to Midland upon gradu-

Another TORRINGTON *Special*

FLAT WIRE MILL
1503



FOR over 60 years, Torrington Manufacturing has been designing and building special machinery for processing sheet, strip, flat wire, rods and tubes, as well as air-cooled or water-cooled molds for casting copper-bearing alloys.

Fine modern facilities include a highly trained design and engineering staff, pattern shop, forge shop, hardening room, welding shop, completely equipped machine shop, and large assembly floor covered by cranes. Experienced, skillful men work under ideal conditions.

Our standard designs can be modified to meet special requirements and we work closely with customers' engineers in adapting machines or designing and building new machines. This collaboration assures special attention to maintenance and production problems.

Privacy is guaranteed when we build from customers' drawings or design and build under their supervision. Materials and workmanship are also guaranteed.

Call or write Torrington Manufacturing with complete details of your requirements. We'll not only build a machine to suit your specifications, but will also help set it up and start it in production in your plant.

FLAT WIRE MILLS (1503) include five units—straightener, breakdown rolls, finishing rolls and take-up, and they convert round wire to rectangular.

FEATURES

RAPID PRODUCTION—anti-friction bearings used wherever possible.

ACCURACY—rolling to thickness ± .00025" and width ± .001".

EASY ADJUSTMENTS—micrometer indicators give precision adjustment.

MAGNETIC GAUGES—for both thickness and width.

TAKE-UP—fully enclosed, but accessible. Arranged for scroll or traverse winding.

INTERNAL WATER COOLING—for breakdown and finishing rolls.

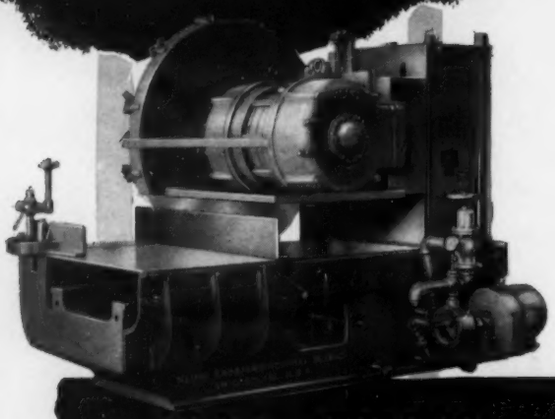
EDGING ROLLS—mounted on tapered arbors for greater accuracy.

FIVE-ROLL ENTRY STRAIGHTENER—non-driven; anti-friction bearings.

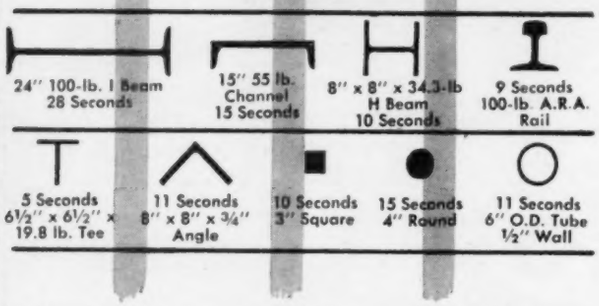
SINGLE MOTOR DRIVE—with drives to edging rolls, finishing rolls and take-up by slip-friction clutches, adjustable while running to compensate for elongation of the metal and spool build up.

The **TORRINGTON**
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT

Modern Sawing



with KLING HIGH SPEED FRICTION SAWS



Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

KLING BROS. *Engineering Works*

Punches; Bar, Angle and Rotary Shears; Combination Shear, Punch and Copers; Plate and Angle Bending Rolls; Heavy Duty Grinders

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ation from Carnegie Institute of Technology, and took employment as a laborer. He was transferred to the inspection department in 1922 and became chief inspector in 1928. In 1936 he was made superintendent of inspection and in 1944 became superintendent of both inspection and metallurgy.

Mr. Meinen has been superintendent of the electric furnace department of the Midland plant since early in 1940, and previously had been with the Universal-Cyclops Steel Corporation in Pittsburgh.

F. E. Kling was appointed chief engineer for H. A. Brassert and Company in charge of the Chilean iron and steel project for the Corporacion de Fomento de la Produccion. Mr. Kling is a graduate of the Royal Engineering College of Dortmund, Germany, and entered the employ of the Carnegie Steel Company at Youngstown, Ohio, in October 1902, as a draftsman

F. E. KLING

and steam engineer. He was made assistant chief engineer, Youngstown works in January 1906, and chief engineer in November 1912. In October 1930 he was made chief mechanical engineer of the Carnegie Steel Company with headquarters at Pittsburgh. At the time of the organization of the Carnegie-Illinois Steel Corporation, in October 1935, he was made chief engineer of the Pittsburgh district. In January 1936, he was made assistant chief engineer of Carnegie-Illinois Steel Corporation, holding this position until his retirement in 1946. He has served as a steel mill consultant for various firms during his retirement.

Barney N. Dagan has been appointed assistant open hearth superintendent, for the Fontana, California, steel mill of Kaiser Company, Inc., replacing **C. W. Conn** who resigned recently to accept a position with the Ford Motor Company. Mr. Dagan was formerly assistant to the open hearth superintendent. Previous to joining Kaiser Company, Inc., Mr. Dagan was associated with the Youngstown Sheet and Tube Company.

Clarence R. Lohrey was appointed assistant superintendent of the coke and by-products department of the iron and steel division, Kaiser Company, Inc., Fontana, California. Mr. Lohrey was formerly coke plant superintendent at Republic Steel Corporation, Cleveland, Ohio.

Louis J. Rohl, formerly metallurgical manager of Carnegie-Illinois Steel Corporation's Chicago district,

FOR TROUBLE-FREE WIRE PERFORMANCE

125 Permanently Insulated ROCKBESTOS Wires, Cables and Cords

From the three basic designs illustrated Rockbestos has developed a complete line of 125 failure resisting wires, cables and cords, a few of which are described. All have the same performance guaranteeing characteristics detailed below. Write for catalog or samples.

Rockbestos Permanent Insulation Insures Long-Lived Service

1. A tough impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease, alkalies and corrosive fumes.
2. Felted asbestos insulation impregnated with heat, flame and moisture resisting compounds will not dry out with age, burn, or bake brittle under high temperatures.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance — protected from heat, flame and oxidation by felted asbestos walls.
4. Impregnated asbestos insulation that withstands heat of overloads and aging and won't become brittle, crack, rot or burn.
5. Conductors are perfectly centered in helically applied non-flowing insulation and will always remain so.

ROCKBESTOS 300 VOLT HEAT RESISTING FIXTURE WIRE
(Underwriters' Type AF)
Sizes No. 10 to 18 AWG stranded plain copper conductor insulated with black or white impregnated felted asbestos—with or without braid.

Rockbestos asbestos insulated fixture wires, approved by the Underwriters' Laboratories for lighting fixture wiring, will not bake out under the high socket temperatures developed in modern high-wattage fixtures. Also used for small motor and apparatus leads, switchboards, etc.

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)
Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

Combine fire insurance and fine appearance in your switchboards with flame and heat resistant Rockbestos A.V.C. Switchboard Wire. Takes right angle bends without cracking because asbestos wall acts as a cushion beneath braid. Rockbestos A.V.C. Hinge and Switchboard Bus cables have same characteristics.

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)
Sizes No. 18 AWG to 2,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 5000.

This cable is recommended for power leads of heat-exposed equipment and circuits that run near boilers, steam lines, furnaces, kilns and other hot spots. It withstands high ambient and conductor temperatures and has ample moisture resistance.

ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE
In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/$25 and No. 9—19/$22. Other strandings on order.

Designed for applications requiring a multi-conductor control cable capable of withstanding high temperatures, corrosive fumes, oil, grease and moisture. It also eliminates fire hazard as it will not burn. Used by equipment manufacturers, power companies, steel mills.

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(National Electrical Code, Type AVA)
Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

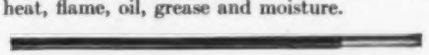
For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard around furnaces, ovens, lehrs, soaking pits, boilers, etc., this permanently insulated wire is ideal. It won't bake brittle, crack, rot, flow or swell.

ROCKBESTOS THERMOSTAT CONTROL WIRE
Sizes No. 14, 16 and 18 AWG in two to five conductors with .0125", .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor wire for fuel burner controls, safety pilots, intercommunications and signal systems. Heatproof, fireproof insulation and steel armor give trouble-proof circuits.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)
Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture.



ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE
Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect motors against heat-induced breakdowns with Class B windings of heat resisting magnet wire. Rockbestos A.V.C. Motor Lead Cable completes the failure-proofing.

ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)
Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

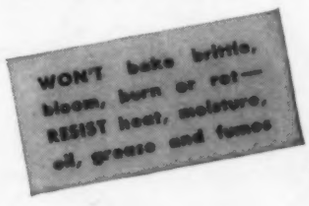
This heat-resisting cord is approved for use in lighting fixtures and is recommended for pendant types as it does not dry out or crack at the socket. Also on apparatus and appliances which develop heat in operation or are used in hot, dry places. Twisted pair, tripled or triplex constructions also available.

ROCKBESTOS A.V.C. 600 VOLT FLEXIBLE CORD
Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos, varnished cambric, felted asbestos, covered with heavy impregnated asbestos braid.

A heavy duty, high-dielectric, heat and moisture resistant flexible cord used in locomotive cab circuits, high wattage lighting units, floodlights and for leads on apparatus exposed to heat. Specify polarized conductors if desired. For high temperature applications where resistance to moisture is not required specify All-Asbestos insulated constructions.

ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AIA)
Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this cable for wiring rheostats, switchboards, elevator and locomotive control panels and equipment exposed to heat, fumes or fire hazard — also for open power circuits in hot, dry locations. For flexible conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable — for solid conductor, Rockbestos All-Asbestos Rheostat Wire.



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The Wire with Permanent Insulation

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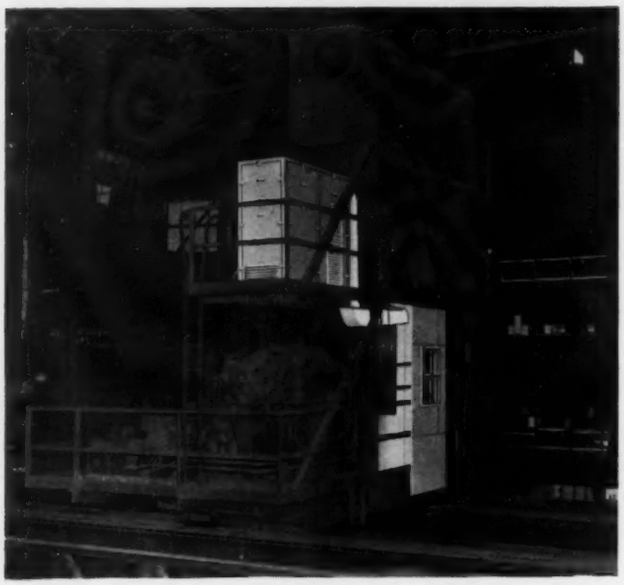


A Pit Crane in the Plant of a Large Steel Company, with Lintern Aire-Rectifier.

Tried and Proved on

Soaking Pit Cranes

This is the only crane cab conditioner which has had thorough testing on soaking pit applications. It has operated successfully in a number of plants under the most severe conditions.

The Lintern Aire-Rectifier, *with air-cooled condenser,* is noted for its low maintenance — operating day after day, month in and month out with little or no maintenance. This is due to its *balanced refrigeration design* which prevents motor overloads in temperatures as high as 170° F. Only periodic inspection is required.

Models are available with or without filtering equipment for all phases of mill operation. This equipment is tried and proved — backed by extensive experience, designed and built by specialists in this field. Ask for Bulletin AC 11546.

THE LINTERN CORPORATION

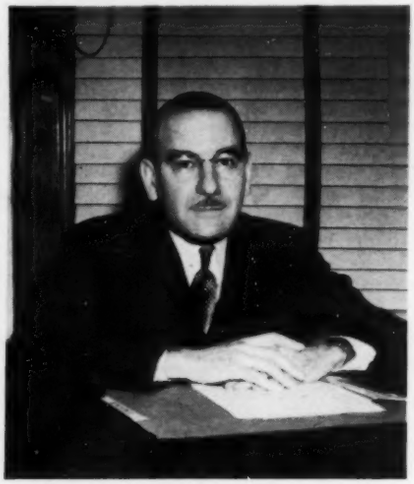
54 LINCOLN AVENUE - - BEREA, OHIO

Aire-Rectifiers, Ventilating Heaters, Glowlites, Crane Safety Equipment, Safety Signals and Markers.

will be promoted to become assistant chief metallurgical engineer in Pittsburgh to aid **Edward T. Barron,** chief metallurgical engineer, in administering the newly consolidated division.

Mr. Rohl has been district metallurgical manager for Carnegie-Illinois since July 1943. He began service with the company 30 years ago at the South Chicago plant. He advanced steadily and in January 1936 became assistant to general superintendent of the plant and soon thereafter was made assistant manager of the metallurgical department.

George L. Stout was appointed manager of Federal Electric Products Company's east central sales district,



GEORGE L. STOUT

located at 939 Edwards Building, Cincinnati, Ohio. Mr. Stout's district includes Ohio, Kentucky, Indiana, West Virginia and Western Pennsylvania.

A native of Lorain, Ohio, Mr. Stout is well known in Ohio and adjacent states, having been formerly associated with the Martindale Electric Company, Colt's Patent Firearms Manufacturing Company, as district manager, and Trumbull Electric Manufacturing Company as district manager, he joined the Federal sales organization last year. Mr. Stout is a member of the Association of Iron and Steel Engineers.

H. A. Roemer, Jr. was elected vice president of Sharon Steel Corporation. Mr. Roemer is president of Detroit Seamless Steel Tubes Company, a wholly-owned subsidiary of Sharon Steel Corporation, and will retain that position with headquarters in Detroit.

ROLLING MILL

FOR SALE — Complete Single Stand — 20½" x 30" **Mesta** Cold Strip Reduction Mill with Forged Steel Rolls, Combination Pinion Stand and Drive, Pinions 1" D.P. 20" P.D. 32" face double helical cut 20° involute teeth, motor 375 hp 230 volt d-c 430–860 rpm complete with controls. Overall space needs 13 ft 6 in. height x 17 ft x 24 ft; approximate weight 211,000 lbs. Condition excellent — operated only one location —prompt inspection arranged. We have replaced this with a larger mill.

Inquire of the owner, American Cladmetals Company, Grant Building, Pittsburgh, Pennsylvania.

Smooth riding means smooth edges

LINK-BELT CONVEYORS

do NOT damage coils

The trend toward mill modernization is a program of cost reduction in steel production. But mechanization, in itself is not enough. Mechanization must be as completely useful as possible if it is to serve its purpose in cost reduction.

Link-Belt Coil Conveyors offer such efficient mechanization. It is not enough to move coils. Coils must be moved *safely* . . . they must be transferred without damage. Movement that scuffs edges . . . that wastes steel . . . is far from effective mechanization.

Link-Belt Coil Conveyors protect as well as transport. Ample bearing surfaces, rugged and rigid construction move coils gently, carefully, safely. Available in designs for handling coils in various positions.

A Link-Belt Engineer will be pleased to discuss your problems.

SERVICE *to* STEEL *by* LINK-BELT

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . . Water-Intake Screens . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Babbitted, Ball and Roller Bearings, etc.

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Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

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PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

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Thin Spots

IN YOUR LUBRICANT FILM

WITH NON-FLUID OIL

TRADE MARK REGISTERED

Even the lightest grades of NON-FLUID OIL when used in the approved small quantities and reduced to a lubricant film, will not flow or spatter from frictional points. It is this exclusive adhesiveness that assures a constant, uniform film, preventing wear and protecting against moisture and corrosion.

This same "built-in" adhesiveness actually saves on lubrication costs, too, because NON-FLUID OIL lubricates dependably until entirely used up and does not drain away when machinery is stopped. NON-FLUID OIL also eliminates costly spoilage of goods caused by dripping and slinging of ordinary oils.

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Please send me testing sample of NON-FLUID OIL to be used in the following machinery:

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Obituaries

Raymond B. Zerfəy, chief engineer, Tool Steel Gear and Pinion Company, Cincinnati, Ohio, died March 31, 1947. Mr. Zerfey was born in St. Mary's, Ohio, July 20, 1887. Shortly after that his family moved to Cincinnati where he lived the remainder of his life. He was a graduate of the Ohio Mechanic's Institute and following this was connected with the Cincinnati Milling Machine Company and then the Cincinnati Car Company. He went to Tool Steel Gear and Pinion Company in September 1917 as head of the engineering department.

Edward F. Entwisle, 64, general manager of the Bethlehem Steel Company's Lackawanna plant, died in Buffalo, New York, on March 8 after a long illness.

Mr. Entwisle, who served in the steel industry for forty years, began with the Carnegie Steel Company at Duquesne, Pennsylvania, in 1907, a year after his graduation from Cornell with a mechanical engineering degree. In 1914 he joined the Maryland Steel Company as an engineer at Sparrows Point, Maryland.

EDWARD F. ENTWISLE

When the Maryland Steel Company was taken over by Bethlehem he was transferred to the plant at Steelton, Pennsylvania.

He had served as superintendent of blast furnaces at the Lebanon, Pennsylvania, Plant, assistant general manager of the Steelton plant; and superintendent of the Saucon division of the Bethlehem, Pennsylvania, plant. In 1936 he was appointed general manager of the Lackawanna plant.

WANTED

ELECTRICAL ENGINEERS—recent graduates or experienced men for sales and engineering work by progressive recognized electrical manufacturer. Preference given to men experienced in the design or application of motors and/or controls. In reply state age, availability, experience, and approximate salary. Box A-106, Iron and Steel Engineer, Empire Building, Pittsburgh 22, Pennsylvania.

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- a Super-heated Problem

Hot gases, chemical fumes and dusty air are handled efficiently and at low cost with the Morgan Air Ejector.

The reason? The gases do not go through the fan. This means temperatures as high as 3000°F can be handled without injury to the equipment and without change in the even flow of exhausting power.

Follow the arrows on the sketch and see how it works. Haven't you a problem that could be solved more efficiently and economically with a Morgan Air Ejector?

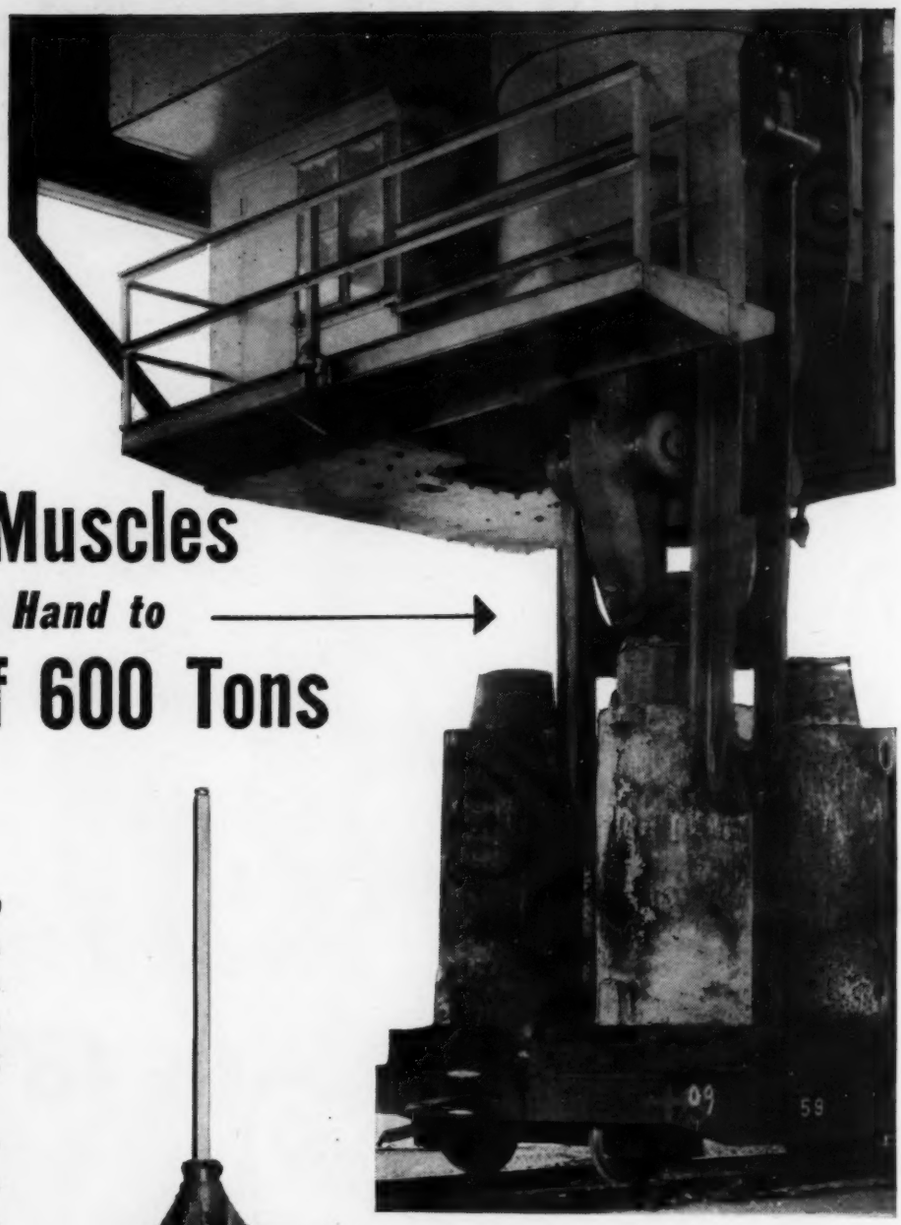
3
The gases are mixed with cool air and discharged at low temperatures to the atmosphere.
1
Cool air is directed upward through the venturi throat, creating a powerful suction in the stack.
2
Super-heated gases, fumes, etc., are drawn out without passing through the fan or motor.

MORGAN AIR EJECTOR

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASS.

PITTSBURGH, PA., 2815 Koppers Building — English Representative, International Construction Company, 55 Kingsway, London W. C. 2, England

CCC-10



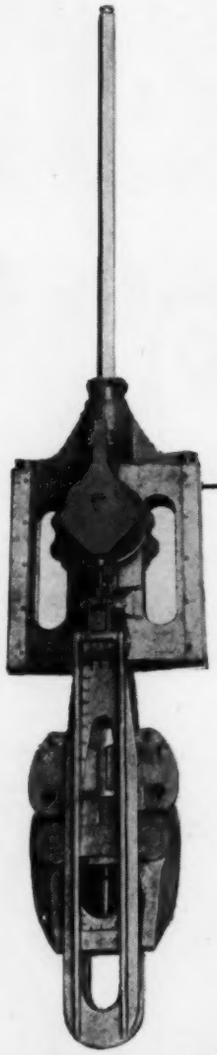
Nickel Steel Muscles

Strengthen this Giant Hand to → Resist Pull of 600 Tons

Although normally rated at 200 tons pressure, the unit shown above strips ingots by means of a giant screw that resists as much as 600 tons when encountering "stickers."

Despite the arduous work performed by screw type strippers in practically every large steel mill, The Morgan Engineering Company, well-known producer of steel plant equipment, states that no user has ever reported failure in this type of screw shaft, which is largely attributed to Morgan's use of a heat-treated, 3½% Nickel steel, type 2330.

This Nickel steel provides exceptional toughness and resistance to fatigue and impact, hence Morgan engineers specify it also for pinions, shafts, and various other stressed parts throughout their strippers.



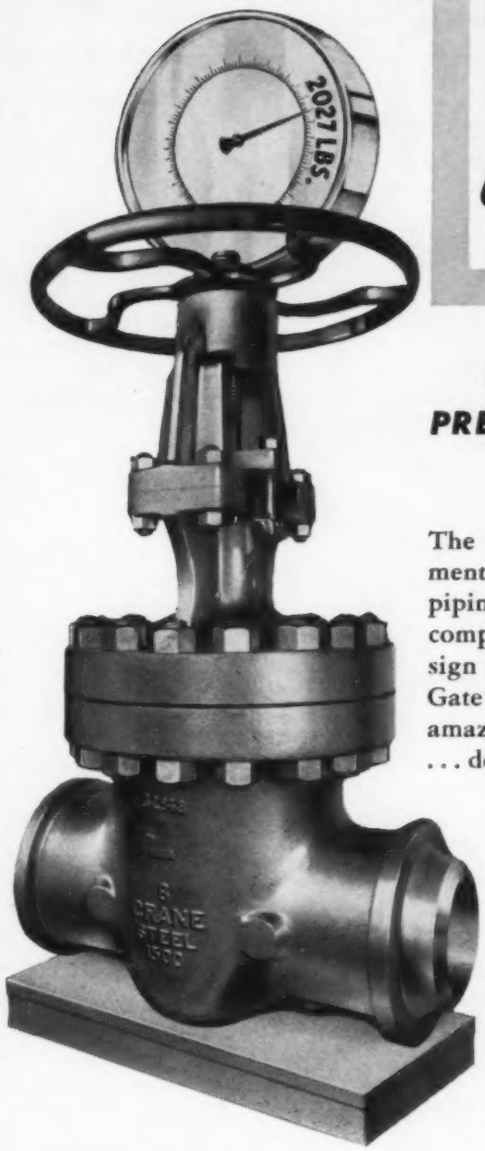
This 17-foot screw shaft of Nickel steel is ready for the latest model Morgan Ingot Stripper. Threaded portion is about 6 feet long. Right and left hand triple threads working in bronze nuts give it a 3 foot pull stroke for handling "hot tops," and a 6 foot 6 inch push stroke for stripping standard ingots.

EMBLEM OF INCO SERVICE
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes and other alloys containing Nickel. This information and data are yours for the asking. Write for "List A" of available publications.

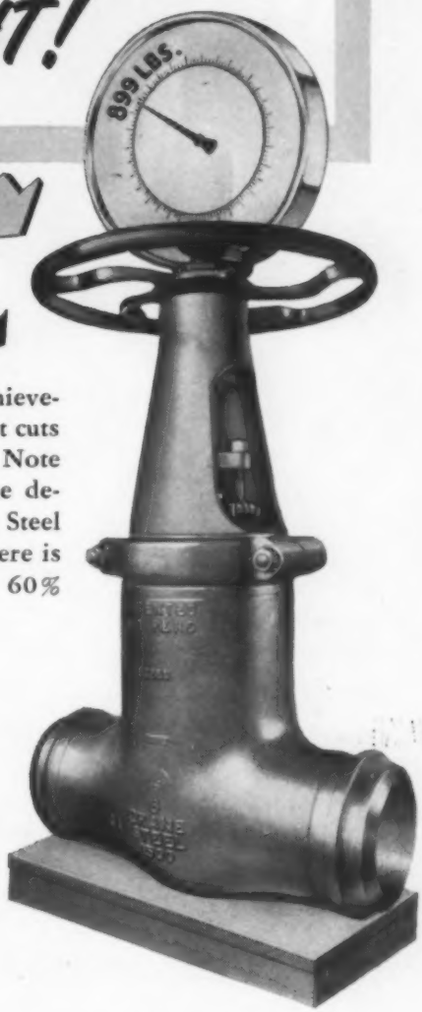
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

40 to 60% LESS WEIGHT!



New CRANE PRESSURE-SEAL BONNET VALVES

The scales show this weight-saving achievement . . . with no loss of strength . . . that cuts piping erection and maintenance costs. Note comparative weights of this new Crane design and the conventional 1500-Pound Steel Gate Valve, both 8-inch. Size for size, here is amazing weight-reduction . . . 40% to 60% . . . depending on size.



OTHER BASIC ADVANTAGES OF THIS NEW PRINCIPLE

1. *Eliminates Bonnet Joint Leakage*
2. *Ends Bonnet Joint Maintenance*
3. *New Streamlining . . . inside and out*
4. *New Ease of Inspection*
5. *New Ease of Operation*
6. *Improved Flow Characteristics*
7. *Reduced Over-all Dimension*

REVOLUTIONARY DESIGN IN STEEL VALVES FOR HIGH PRESSURES AND HIGH TEMPERATURES

No valve improvement in a quarter-century compares with the Pressure-Seal Bonnet principle. It completely eliminates the customary flanged bolted bonnet joint with its problems of leakage and maintenance. The joint is inside the valve—automatically sealed by fluid pressure. This new principle, as applied by Crane, brings a whole new set of standards for on-the-job valve efficiency.

The Crane Pressure-Seal line includes gate, globe, angle, and automatic stop-check patterns with welding ends. Complete information regarding performance and adaptability to your requirements supplied on request.

1500-Pound Crane Pressure-Seal Bonnet Globe Valve

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas.

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Mis-alignment that causes wear . . .

can happen in bearings just as it occurs in an automobile tire when the wheel is "out-of-line." Rapid wear, friction, and stresses caused by mis-alignment can result in premature bearing failure. These factors can be

Eliminated with self-aligning bearings

The Torrington *Spherical* Roller Bearing is self-aligning. Any mis-alignment due to shaft deflection, lack of rigidity or other cause is compensated by the bearing itself—without lessening its radial or thrust capacity.

This unique feature of the *Spherical* Roller Bearing is responsible for its rapidly increasing use. If you do not have a copy of our Technical Bulletin #200 on this newest addition to the line of Torrington Bearings, a request on your letterhead will bring you a copy promptly.

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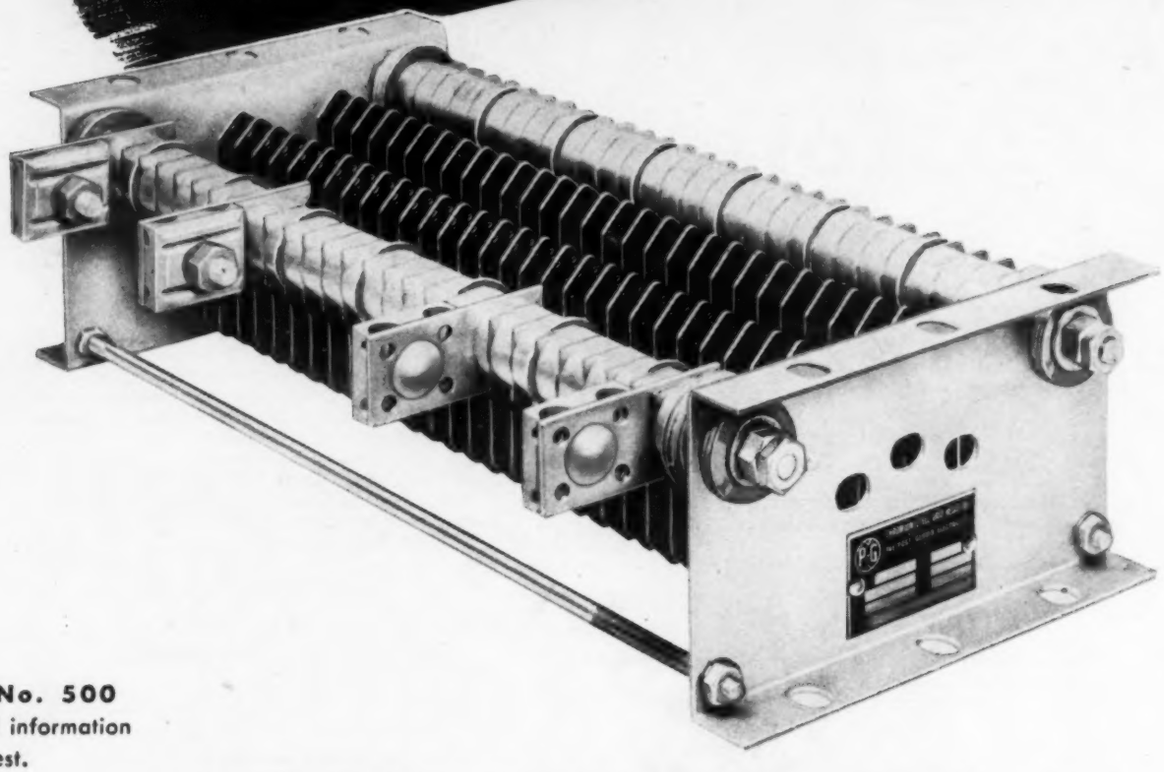
P-G

Steel Grid Resistors HELP KEEP EQUIPMENT IN *Continuous* OPERATION



BULLETIN No. 500
Gives detailed information
Copy on request.

P-G nonbreakable steel construction and mica insulation, with provision for expansion enables P-G Steel Grid Resistors to withstand many factors responsible for resistor failure. By reducing failures and thus minimizing hours lost in electrical repair and maintenance, P-G Resistors will do their part to keep your production equipment in continuous operation.

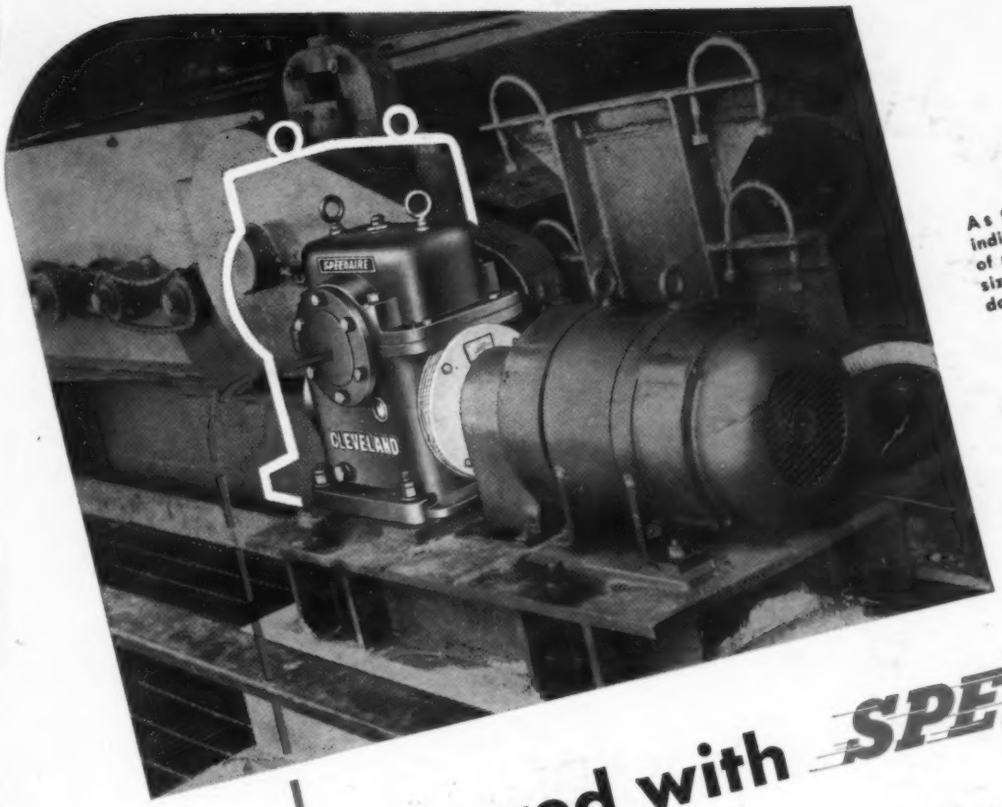
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



As the white outline indicates, a standard unit of nearly twice the frame size would be required to do the work of Speedaire.

28% of cost saved with SPEEDAIRE

THIS Speedaire is installed in a well-known Ohio steel mill. It drives the rolls of a pickler through which steel sheets pass before hot dip galvanizing.

In selecting Speedaire for this job, the company saved three ways: It *saved dollars*—28% of the cost of a standard worm-gear speed reducer. It *saved weight*—36.6% of the floor load. And it *saved space*—50% of the room required to accommodate a conventional unit.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantages of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3278 East 80th St., Cleveland 4, Ohio.

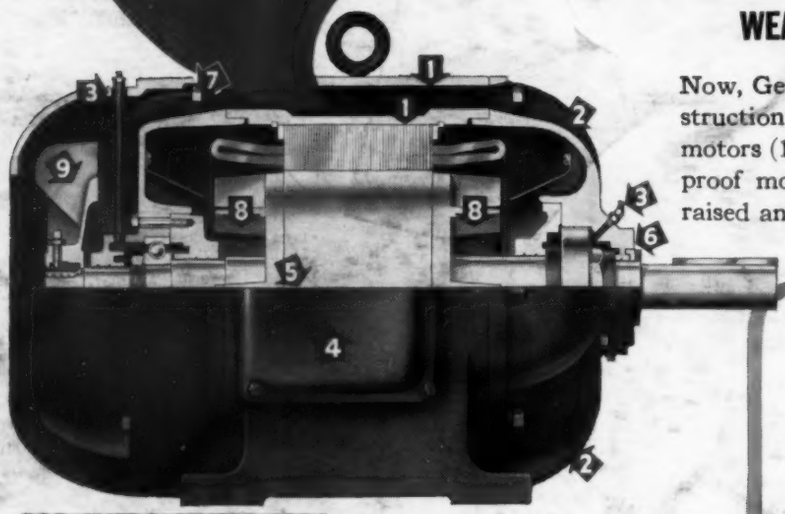
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

A DOUBLE WALL *Keeps trouble out*

NEW *TRI/CLAD* TOTALLY ENCLOSED MOTOR IS MORE FULLY PROTECTED FROM DUST, DIRT, WEATHER, OR WHAT-HAVE-YOU . . .

Now, General Electric has applied Tri-Clad construction to its line of totally enclosed induction motors (1 to 1000 hp) and to most of its explosion-proof motors as well. *Extra protection* has been raised another notch.



FOR EXTRA-SEVERE JOBS

Applications amid abrasive dust and corrosive atmospheres, such as coke conveyors, sintering plants or pickling line drives and auxiliaries, where totally enclosed motors have been standard, now have the benefit of stronger armor plus convenient servicing features.

FOR EXTRA-WET LOCATIONS

Indoors or out, on blast furnaces or on roll coolant pumps, these Tri-Clad totally enclosed motors will withstand rain and hydraulic spray without danger of shutdown. The cast-iron frame is strongly resistant to rust and corrosion.

HAZARDOUS ATMOSPHERES

Tri-Clad explosion-proof and dust-explosion-proof types are listed by the Underwriters' Laboratories for Class I Group D, Class II Groups E, F, and G applications, such as in coke by-product plants.

FOR EXTRA LONG LIFE

Many motor users are making the totally enclosed motor their standard for *all* jobs—based on evidence of long-term savings. This new member of the Tri-Clad line makes this decision more logical than ever.

THESE 9 POINTS

of new strength and serviceability put this Tri-Clad totally enclosed motor way ahead

1. A cast-iron, double-wall frame that completely encloses windings and punchings

2. Ribbed cast-iron end shields, machined to provide a tight seal, yet easily removed

3. Well proved pressure-relief greasing systems which can be packed with a long-life lubricant where advisable

4. Cast-iron conduit box diagonally split for wiring convenience (independently explosion-proof on explosion-proof motors)

5. Leads are sealed in a nonshrinking compound at the point where they emerge from frame

6. Rotating, labyrinth seal prevents infiltration of grit or liquids

7. Large, free-flowing, easy-to-clean air passages protect parts from accumulation of dust and foreign matter

8. Modern "ageless" insulation treatment includes Formex* magnet wire

9. Powerful external fan is removable, simplifying maintenance. (Nonsparking type for explosion-proof motors.)

AND IN ADDITION —compactness and short length promote ease of handling and installation.

*Trade-mark Reg. U.S. Pat. Off.

GENERAL ELECTRIC

GEA-40-8058

FOR THE COMPLETE STORY

GENERAL ELECTRIC COMPANY
Apparatus Dept., Schenectady 5, N. Y.

Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motor.

Please send me GEA-4131, "Motors and Control for Hazardous Locations."

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